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ELECTRIC POWER IN MINES.

The increasing use of electric power in mining has been referred to recently, but it seems worth while to make a note of the attention which this application is receiving just at this time. In the present issue of the ELECTRICAL REVIEW there are two contributions on this subject—one describing some typical German mining installations, and the other giving a summary of the report prepared for the British home office on the use of electricity in coal mines.

Motor-Driven Pumps.

In the first contribution, Mr. Emile Guarini describes a number of important German applications of the electric motor to mining work. These systems are, for the most part, operated by polyphase machinery, and the motors have been found thoroughly reliable under the conditions obtaining in and about mines. The use of motors for pumping in mines is not new. The ease with which the power may be transmitted electrically to the point of utilization gives the electrically operated pumps a flexibility which no other system possesses. The same is true of the ventilating apparatus, though, in this case, the conditions to be contended with are not as severe.

Electric Winding Engines.

A newer application, and one which necessarily has come into use more slowly than electric pumping or ventilation, is the electrical driving of winding engines. The winding engine is usually located at the surface of the ground, and there is therefore not as great a necessity for an efficient and flexible transmission. Then, too, mining engineers are familiar with the steam operated winding engines, and it is only natural that they should be slow in discarding a well-tried system for a new one, even though the advocates of the new promise much better results without a sacrifice in reliability. Large winding engines have been operated by electric motors for some time, and, we believe, have in every case demonstrated their trustworthiness.

Comparison of Electricity and Steam.

A comparison made by M. Guarini of electric and steam operated systems is very favorable to the former, both as regards operating expenses and the cost of installation. These figures are, of course, only applicable to conditions obtaining in Europe. It is possible that European engineers are a little ahead of us in the application of electricity to certain lines of mining work, as conditions are rather different in this country. Electric mine locomotives and electric coal-cutting machinery are familiar enough over here.

British Report on Electricity in Mines.

The report of the British home department on the use of electricity in mines is very important to the English companies. This report is quite full in some respects, yet lacks in others.

On some points the recommendations are specific, and on others a wide choice is left, without any recommendation as to the safer class of machinery. The report will, however, help to standardize English practice, and the recommendations are conservative and, in the main, in agreement with the best practice.

THE BLOWING OF THE FUSE.

Although attention has been called repeatedly to the fact that when the fuse on an electric car blows, it is not an indication of danger, it takes a long time and many repetitions to impress this fact upon the riding public. Only recently a panic, produced by this cause, called forth the following excellent editorial from our esteemed contemporary, the *New York Times:*

Again the usual and harmless accident of the blowing of a fuse on an electric surface car has resulted in a senseless panic with more or less serious injury to those involved who were least able to protect themselves.

How soon will people who habitually ride in cars learn from experience that the flash which accompanies the blowing of a fuse is all there is of the accident, except the subsequent pushing of the "dead" car back to the depot by the one which follows it? There is a glare of bluish-white light, and then as the blast captain would say, it is "all over." Even if the car takes fire, its construction is such that before any one could be injured a load of cripples could make the sidewalk in safety and comfort.

The fuse in car equipment is, in fact, what the deacon who built the wonderful one-horse shay sought to avoid. It is the "weakes' place." When the current reaches a volume or intensity which might be dangerous, the fuse "blows." For this purpose it is provided, serving the function of a safety valve in a steam boiler. It means instant safety and absolute freedom from other danger than that created by the mad rush of cowardly men and hysterical women for the doors—a danger which those escape who keep their seats. Perhaps the iteration and reiteration of this elementary fact in electrodynamics may ultimately make an impression upon the public mind. If not, we shall have to wait until the beneficent operation of the law of the survival of the fittest shall have eliminated those who start panics by rushing shrieking for the doors the moment the one thing happens which means that nothing more can happen.

Editorials of this kind will do more to avert accidents on electric cars than any number of technical discussions or sharp criticisms of the railway companies. We do not mean to say that where the company is to blame, either for carelessness of its employés or for operating unsafe cars, this should be overlooked; though editorial criticisms of such nature unfortunately tend to make the riding public more nervous, and, therefore, more apt to go into a panic. We all of us have a wholesome dread of electricity, but the public can not learn too soon that the electric car is an exceedingly safe type of vehicle when properly operated. As our contemporary remarks, "even if the (surface) car takes fire, its construction is such that before any one could be injured a load of cripples could make the sidewalk in safety and comfort"; and the same should be true of the elevated trains, for there should be ample time, in case of one car taking fire, to transfer the passengers to the others and to detach the burning car. To do this, it is necessary, of course, that the employés should not lose their heads, and it is the business of the operating company to see that it has such men. These facts can not be stated too often, and when they are fully appreciated we may expect a marked diminution in the number of electric car accidents.

THE PRESENT CONDITION OF RADIOACTIVE SCIENCE.

It is seldom that a discovery so purely scientific as that of radioactivity has awakened and held the interest of the lay mind as persistently as has that of radium. This is, perhaps, partly due to the lively interest shown in this new field by the scientific world, which usually receives and discusses new discoveries rather as a matter of course. But these new phenomena, with their apparent paradoxes and surprises, disturbed the usual scientific calm and started so many skilful investigators to work that it is difficult, even for those who make it a point to follow the science, to keep informed in regard to the latest development. There is no doubt, also, that the popularity of "radium" has been fostered by the unwarrantable deductions which have been drawn by those not fully informed of all the facts. Radium has been hailed on the one hand as a source of unlimited power and on the other as a cure for all diseases, and its use has been suggested for about everything between these extremes.

Misuse of Term "Radium."

The term "radium," by the way, is being rather misused. The radioactive substances which one sees exhibited are not radium, but the salts of this element, and they should be called by the proper term. To call them "radium" is just as incorrect as it would be to call sugar "carbon."

The Process of Disintegration.

Those who are interested in radioactivity will find in the concluding article of a serial on radioactivity published in the *London Electrician* by Mr. Frederick Soddy, a summary of the present condition of this science. It will be remembered that radioactivity is now supposed—by one school of physicists, at least—to be brought about by the disintegration of the atoms of radium or the other elements having this property. This disintegration apparently takes place in stages, each stage occurring abruptly, the character of the change in the different stages being different for the several substances. There exist during these intermediate stages transition forms differing both from the primary and final result. Thus, for thorium the first transition form to be produced is thorium X, which is distinguished from the thorium itself by differences in the chemical properties. The next stage produces the thorium emanation, in which a volatile substance is set free. The third and last stage produces a substance not volatile. In the case of radium, a gaseous emanation is set free during the first stage of disintegration, and this changes into a non-volatile matter. In uranium only one intermediate form is known.

The Radioactive Effects.

During these disintegrations three actions may be distinguished. These are designated by the three radiations, the α, β and γ. The α radiations are supposed to consist of small particles of matter having sizes of the order of the hydrogen atom, which are shot off from the material at velocities at times as high as 20,000 miles a second. Since the radioactive substances have atomic weights over 200 that of hydrogen, a number of these particles might be lost by an atom without materially affecting its atomic weight. The β radiations are supposed to

be particles much smaller than the α particles, and are thrown off with much greater velocity, in some cases approaching the velocity of light. The γ radiations are not supposed to be particles of matter, but real etheric vibrations similar to Rœntgen rays or light, except that they are far more penetrating. Thus, as the heavy radium or thorium atom disintegrates, it throws off particles about the size of hydrogen atoms—that is to say, weighing about one-two-hundredth of the atom. It may throw off particles in size about one-seven-hundredth that of the hydrogen atom, and, in throwing off the latter, the invisible light waves are set up.

Other Phenomena.

These views have naturally encountered strong opposition, though they seem to offer the best explanation of what takes place. But the whole story has not been told. According to the electron theory, atoms are made up of groups of electrons, the latter being the small unit charges of negative electricity. One would expect, then, that the α rays, which represent the positive charges, and the β or negative charges would be produced in equivalent quantities; but this is not found to be the case. In the first stage of disintegration the α particles only are set free. And, furthermore, it appears that, although the atom may throw off a positive charge, the residual matter may remain positive. It would seem that there must be some energy changes going on which have not yet been determined.

Is All Matter Slowly Dying?

Another interesting side of this subject is the explanation of how it happens that these unstable compounds have persisted through the ages until to-day. These changes are taking place with extreme slowness, and it is even possible that the radioactive materials themselves are intermediate stages in the disintegration of a primal element. On the other hand, it may be that all matter is passing through this process of disintegration, is living its life, though the change, as compared with that of the radioactive materials, is so slow as not to be detectable. As shown above, an atom might lose particles without the change in atomic weight being detectable. The change may be so slow that the electrical effects are not measurable, and the products can not accumulate in sufficient quantities to be detected by chemical means.

THE DISPERSION OF FOGS.

Not long since attention was called to the suggestion of Sir Oliver Lodge, that fogs might be dispersed by means of electric discharges into the atmosphere at high voltages. Tests which he had made were successful, though the area affected was quite limited, and it is doubtful whether his process could be carried out on a sufficiently large scale to make it of great value.

Use of Ozone.

This idea is brought to mind again by the work of two Germans, Richarz and Schenck, who have found a striking analogy between radioactivity and the behavior of ozone. Freshly prepared ozone has the power of causing condensation in a steam jet. Now, ozone is a gas which can be made easily in large quantities, and it might be possible to make use of its power to disperse fogs. The ozone could be set free at various points, and would rapidly disperse itself through the fog. Just what effect would be secured can not be said. It may be that the condensing effect is too slight to be of any practical value. However, further investigation of this property should be made, with a view to determining how long its power persists, and what quantity of ozone is required to keep a certain volume of air clear. The experiments could be conducted easily at some of the ozone water sterilizing plants which are now in operation.

THE RETURN OF THE FAN MOTOR.

About this time of the year the electrical supply houses begin to lay in a stock of fan motors, which a little later will be put to work throughout the whole of the country, keeping the air in offices and dwellings cool and fresh. The fan motor has been a great favorite since its introduction, and has lost nothing in popularity through familiarity. In fact, it is becoming more and more indispensable in the office, where it frequently retains its place throughout the year. There are many occasions, even during the severest winter, when it is pleasant to put our old friend to work for a little while and stir up and renew the air in a busy room.

Perhaps a word of advice to those who intend purchasing fan motors some time during the coming season will not be amiss: this is, get your motor early. Frequently some of the most oppressive days, and those on which a fan motor is most appreciated, are the first really warm days. Later on in the summer, when we are a little more hardened to the weather, we are less affected by a close, hot day. It pays in comfort to get your motor soon and have it put in place to be ready at any moment for stirring up and refreshing the air in the room. And another point should not be forgotten: place the motor where it will do the most good—that is, where it will draw in fresh air from the outside and drive the warm, stale air out of the room.

COPPER.

Copper is such an important metal in the electrical arts that we are apt to overlook its use in other industries. It is indispensable in the form of alloys, as brasses and bronzes, but even unmixed with other metals, its high ductility and conductivity for heat make it of great value to the steam locomotive designer, who uses it in the construction of the firebox. The problem before the locomotive designer is to secure the greatest evaporation with the least heating surface and with the best economy of coal possible. He therefore uses copper for his firebox walls, because of its high conductivity, and because it is less affected by changes in temperature when stoking than is iron.

Copper is also frequently used in constructing pipes. When in a pure condition it corrodes slowly. It is one of the easiest metals to deposit electrolytically, so that electrotypers would be at a loss without it; and it is used to cover the bottoms of wooden ships, because its salts are poisonous to marine growths. In all of these applications some property of copper entirely separate from its high electrical conductivity is turned to account.

The Electrical Mining Installations of the Hélios Electrical Company.

By Emile Guarini.

THE application of electricity in exploiting mines is one of the important problems of electrotechnics, and the Hélios Company, of Cologne, Germany, has taken an active part in its solution. It has endeavored, by appropriate and practical construction, to respond, under all conditions, to the particular exigencies of mining exploitation, and has met with an ever-increasing success. It has created in various localities installations having the qualities necessary to excite the confidence and interest of those who are occupied in the exploitation of mines.

The greater number of the mining installations of the Hélios Company are alternating systems, a choice dictated by the ease of transmission and of transformation which this system presents. These qualities are particularly advantageous in mines, where the points of utilization are generally some distance from the generating station. The special conditions which are found in mines necessitate the use of enclosed motors.

To transform the current from high tension to low tension the company has adopted the core type of transformer, and by dividing the primary and secondary coils into sections, and alternating them, avoids magnetic leakage. These transformers may be used simultaneously for both lamps and motors. Under normal load the temperature rise is not more than forty-five degrees above that of the surrounding air.

The types of application which at this time particularly occupy the attention of this company are pumping, ventilation, winding gear, and work on the surface.

For large pumping installations the Hélios Company prefers a motor directly connected to a high-speed or so-called "express" pump. Different makes of pumps are employed, such as the Ehrhardt & Sehmer, the Bergmann and the Riedler.

The pumps of the first and last-named companies are peculiar. The Ehrhardt & Sehmer pumps are marked by special mechanical construction. The bearings are cast with the base, the latter having wells in which the oil is collected after having been used for lubrication. A small pump, fixed laterally to the base, circulates the oil through a piping system, which distributes it to the different points to be lubricated, and in this way maintains a positive and continuous circulation. The pump is of the single-acting piston type. The valves operate vertically, and are arranged in such a way as to be removable successively. The valve seats are held in place by a lateral screw. The plunger pistons are connected directly to the connecting rods, without the use of piston rods. Special means for lubricating the packing has been adopted. A Mollerup press forces the grease into channels cut in the rear of the gland, and keeps the packing perfectly lubricated.

The efficiency of the Ehrhardt & Sehmer pumps is practically ninety-four per cent. Normally there are but two bearings. For pumps of small output a single crank and one frame on one side of the motor have been adopted, while for pumps of large power there are always two bearings and one frame on each side of the motor. To secure the most uniform conditions possible each frame carries a double-acting pump, one piston plunger being driven directly from the cross-head, and another at right angles to the first, driven also from the cross-head by two lateral rods, in such a manner that there are two strokes of the piston for each revolution of the motor.

The Riedler pump is driven directly by a motor, and is characterized by having its suction valves concentric with the plunger. This valve consists of a single metallic ring covered with wood, leather or hard rubber. The seat of the plunger is maintained in place by rods which, at the same time, guide the valve and support its weight. Pressure screws passing through the cover maintain the guides. The guides serve also to limit the lifting of the valve, and for that end they are provided with a rubber stop. As the valve is not loaded with springs, and its weight is supported by the guides, it offers no resistance to the passage of water. It remains open throughout the whole period of suction, and it is then moved by attachment to the plunger head, which closes it at the moment the crank passes the dead point. In order to avoid injury to the valve, the attachment is covered with rubber. To remove the valve it is necessary to take off the cover, then the guides, next the head of the plunger, and finally the valve and seat. The discharge valve is formed of rings, fitted as the preceding. These rings are loaded with rubber springs maintained by a cap. The seat is held by the case, which serves at the same time as the joint of the bell. In order to remove the valve, it is necessary to take off the bell and the sheath.

There is nothing particular to say about the ventilators, except that, contrary to the practice of others, the Hélios Company drives directly even the large principal ventilators which are ordinarily driven by means of belts. In the description of installations an instance will be noted where a ventilator having a diameter of four metres is driven directly by a 400-horse-power motor.

The winding machines installed by the Hélios Company consist generally of two drums two metres in diameter, covered with oak for a space of eight to ten centimetres. On the axle of each drum is applied a brake operated by foot. On the shaft of the gears acts another brake operated by an electromagnet which is automatic. This device consists of an electromagnet placed in the motor circuit, and attracting the armature whenever current flows. The armature then frees the brake. Should the current be interrupted, the armature is no longer attracted, and the drum is stopped. The starting and control of the speed of the motor are effected by means of controllers similar to those used on electric cars.

Passing now from general considerations, it would be well to take up in particular the installations made by the Hélios Company, which will show better than all comments the value and originality which these electrical mining installations present.

Perhaps one of the most recent of these installations—it dates from 1902—is that which has been made at the Gneisenau mine, near Dortmund, and which is used principally for draining. The system is three-phase at 2,500 volts, 3,000 alternations per minute. It includes two dynamos (Fig. 1) driven by steam, and each giving 625 kilowatts. There are two transforming groups for excitation and lighting by continuous currents. The first group is rated at fifty kilowatts, and the second at thirty-eight. There is, in addition, a continuous-current dynamo of thirty-eight kilowatts for excitation.

An underground installation for draining includes two Ehrhardt & Sehmer double-acting pumps. They have two suction chambers, four discharge chambers, and one discharge chamber common to both pumps. They are placed at a depth

of 380 metres, and draw water from three to four metres below them. The output at sixty-one turns per minute is 5.3 cubic metres. The diameter of the rotor of the motor is 3.6 metres, and the length axially is 0.61 metre. It can be started by a special generator or by current taken from the main line. For the latter case it is provided with an oil starting device, slip rings, and a mechanism for short-circuiting them and lifting the brushes. The stator is made in four parts, and was wound in the mine. The rotor consists of two parts. Numerous air channels have been left in the iron for cooling purposes. As mentioned above, the motor may be started directly from a generator by short-circuiting the motor slip rings and connecting the primary leads to one of the dynamos which is not in operation. Upon starting the latter the motor turns with it and runs up to full speed with the generator. This method is simple and does not require any brushes on the motor, but has the inconvenience of necessitating the preliminary stoppage of a generator and calls for a double distributing line, one for lighting and the other for the motor. In the second method the motor is put into service by an oil-cooled starter, which throws resistance into the rotor circuits. This starting device consists of a series of contacts arranged around a vertical shaft, upon which fixed brushes press. It resembles a commutator with air insulation. The resistances are formed of circles of nickel arsenate, placed in an oil bath. As the brushes are fixed, the resistance is varied by revolving the vertical shaft. This also keeps the oil in circulation.

The total efficiency of the installation is 68.6 per cent. Drainage has been provided for a depth of 450 metres, and should, at any time, that maximum be attained, the steam engines will develop their maximum of 800 horse-power.

Quite recent also is the installation, with Riedler pumps, which was shown at the pavilion of the Gutehoffnungshütte, Oberhausen, at the Düsseldorf exposition. The pump operates at 200 revolutions per minute, raising 2.5 cubic metres of water per minute to a height of 600 metres. The diameter of the plunger is 18.5 centimetres, and the travel is twenty-five centimetres. A flanged coupling connects rigidly the shaft of the pump to the rotor, which acts as a flywheel, the motor being a three-phase asynchronous machine, operating at 200 turns per minute, at 6,000 alternations. This motor develops from 430 to 500 horse-power, and is fed directly at 2,000 volts. The stator consists of a carcass of cast iron, formed in two parts. Its extreme diameter is 2.68 metres, the maximum length, ninety-one centimetres, and the air gap is 1.75 millimetres.

The rotor has a definite winding and is fitted with slip rings and a device for short-circuiting the windings and lifting the brushes. It is fitted with self-oiling bearings, and requires but little attention. The air compressor of the pump is driven through gearing by an eight-horse-power three-phase motor operating at 960 revolutions per minute, under a tension of 110 volts. Its starter, as well as the measuring apparatus and switches, are placed in an iron distributing case. The ammeter, voltmeter and the various controlling handles are arranged on a multiple switchboard placed at the extremity of this case. Liquid resistance is used for starting, and there are two iron electrodes which plunge into a solution of soda after the main

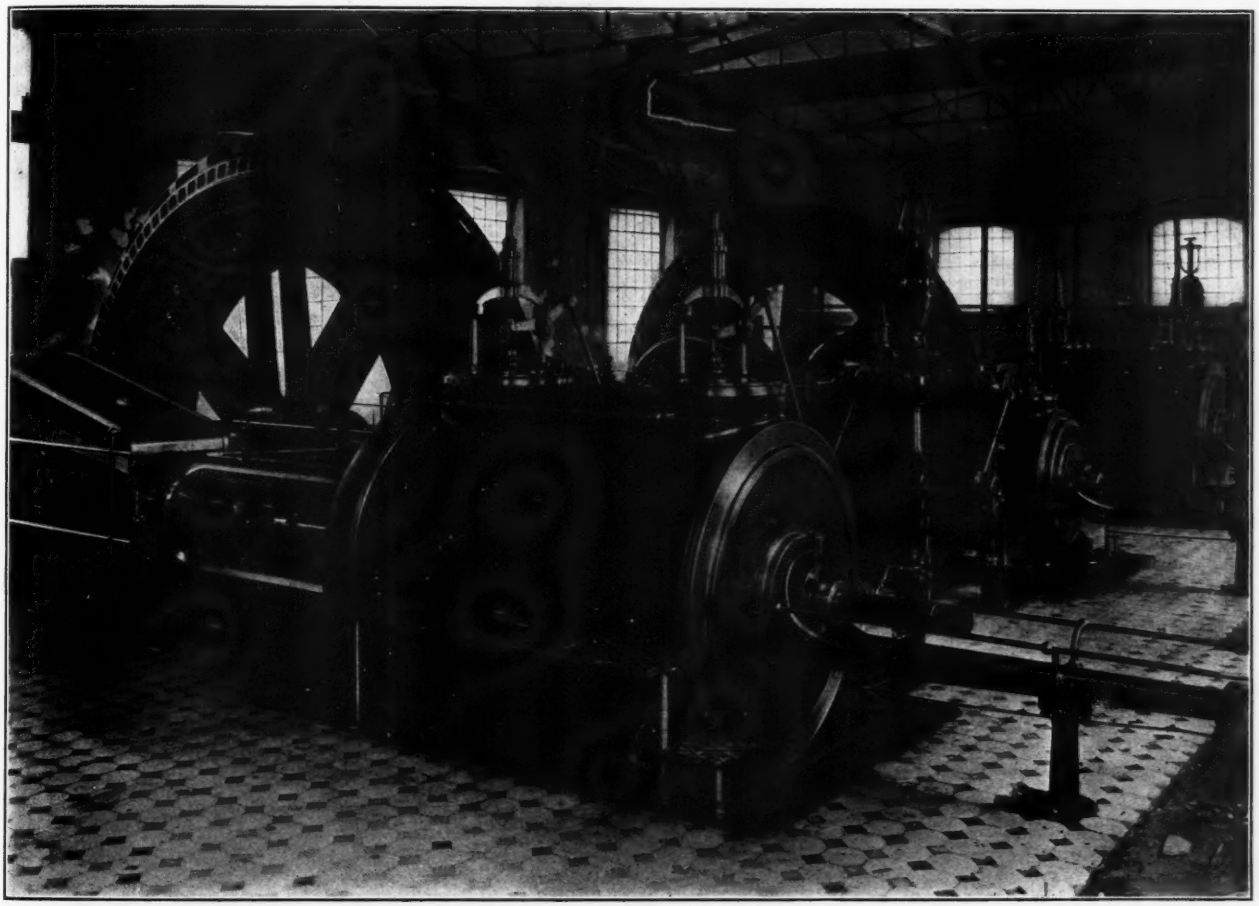


FIG. 1.—SHOWING TWO 625-KILOWATT DYNAMOS, DRIVEN BY STEAM ENGINES, AT THE GNEISENAU MINE, NEAR DORTMUND.

switch is thrown. The motor absorbs fifty amperes at starting. When the electrodes have reached the bottom of the solution, they are automatically short-circuited, and then the windings of the rotor are short-circuited and the brushes lifted from the slip rings. The operation requires about one minute. At full load the power-factor of the motor is 0.83, and its efficiency is ninety-three per cent.

The installation made at the Rheinelde mine furnishes a new proof that electrotechnics can solve the most difficult problems. The problem here was the sinking of the fourth level of the Rheinelde No. 2, without interfering with the operation of the existing hoisting system.

It was impossible to use a mechanical installation set up in the building at the opening of the mine, nor could use be made of steam engines or compressed-air machinery set up in the pit. There remained, then, electricity, and the Hélios Company was put in charge of the work. The station was placed at the opening and consists of a steam engine of 600 horse-power, driving, by means of a belt, a continuous-current compound-wound dynamo of forty-four kilowatts. Preference was given to continuous current at a tension of 500 volts, because the distance of the point of utilization was such that it could be used economically. The fall in voltage of the dynamo winding is compensated for by the compound winding, so that the voltage remains constant at the point of utilization. The continuous-current motors have also the advantages of requiring less current than three-phase motors, and of weighing less. Finally, continuous currents were preferred because they develop a large turning effort at the moment of starting.

The winding engine is placed at the third level, at a depth of 354 metres. It consists of two drums, two metres in diameter and eighty-five centimetres long, provided with a coating of oak wood eighty centimetres long, grooved to receive the cable. On the axle of each of the drums is a grooved cylinder for the band brake, which is operated by foot. The transmission shaft which drives the drums is also provided with a cylindrical brake, which can be put in action electromagnetically. Each of these brakes can arrest the machines instantly.

As mentioned above, the motor is a continuous-current machine and develops normally forty and one-half horse-power, but this output can be doubled. It was constructed by the Hélios Company, while the mechanical part of the winding machine was built by the firm of Wolff, of Essen. The motor has four poles and is open. No shifting of the brushes is necessary with a change of load in order to avoid sparking, and, further, the location is such that the motor is well protected and not exposed to deterioration.

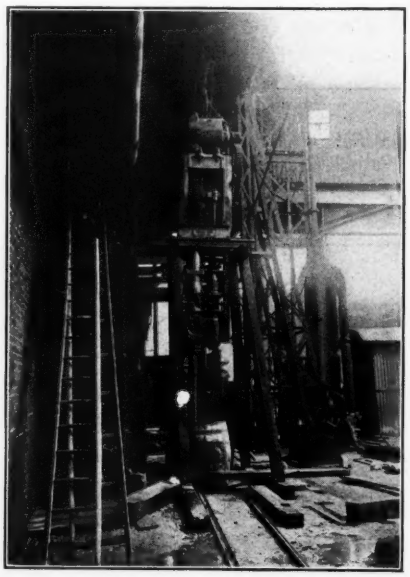


FIG. 2.—SHOWING ENCLOSED MOTOR, DRIVING HEADING PUMP.

The operation of the electric brake is simple. The magnet winding is placed in the motor circuit and attracts the armature whenever the motor is thrown on the circuit. This frees the hoisting drum. Should the motor be thrown out of circuit, either intentionally or by accident, the brake is at once applied to the drum.

The controlling apparatus for the motor allows it to be run in either direction at various speeds. The controller is provided with magnetic blow-outs, a precaution which is of importance, since the contacts are made at least fifty times an hour, and there would otherwise be rapid deterioration. The generator drives, in addition to the winding machine, a heading pump. Electrical control is advantageous, since there is no piping for steam or compressed air, no waste of energy, and prolonged operation for months without inspection is possible. Enclosed motors may be used in damp and dirty places. A motor of this type is used for the heading pump, as shown in Fig. 2. It weighs but 600 kilogrammes, and develops constantly nine horse-power, but this can be increased to twenty. Carbon brushes are used, in a fixed position. Inspection and oiling are necessary only every three or four months. The pump was furnished by the firm of Paschke & Company, of Freiburg. It raises 500 litres of water per minute to a height of fifty metres. This installation has been in operation since 1899, and has at all times given entire satisfaction under all conditions.

An example of ventilating equipment of the Hélios Company is that installed at the Germania II coal mine. The ventilator has a diameter of four metres, and is directly coupled to a 400-horse-power three-phase motor, taking current at 2,000 volts and operating at first at 190 and later at 238 revolutions per minute.

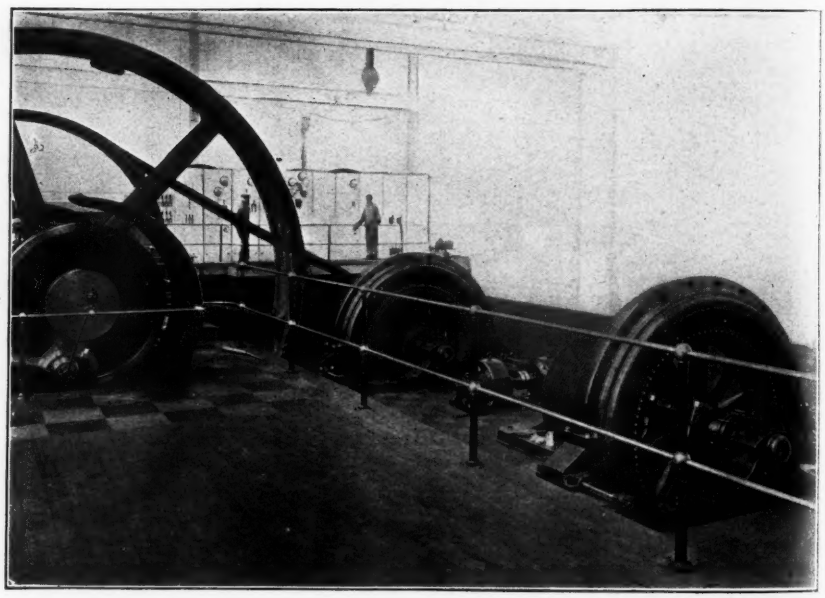


FIG. 3. SHOWING TWO THREE-PHASE 300-KILOWATT GENERATORS AT THE COAL-WASHING PLANT, SCHARNHORST MINE.

A coal-washing installation, driven electrically, has been installed at the Scharnhorst coal mine. Here there is also a

power station containing provisionally two three-phase 300-kilowatt generators revolving at 500 revolutions per minute and generating at 500 volts (Fig. 3). The main pump, the centrifugal pump, the waste pump, the screens, the crusher and the elevator are all driven by three-phase induction motors of from 10 to 100 horse-power. There are, in addition, eight other motors used for separation and ventilating the building.

The installation at the Germania I mine is important. It consists of a draining pump and a winding engine. The pump is of the "express" type, of the Bergmann system, and the output at 100 turns per minute is three cubic metres per minute raised 160 metres. This is driven by means of a three-phase 160-horse-power 2,200-volt motor, mounted directly on the axle of the pump and is shown in Fig. 4.

The winding engine is placed in a ventilating shaft. The mechanical part was furnished by the Bernburger Machine Manufacturing Company, of Bernburg, and is shown in Fig. 5. The digging of the shaft not having been completed, the machine was used for this work. When the shaft is completed it will serve for raising and lowering men and material a distance of 450 metres. It will have a single skip, which will be balanced by a counterweight. The useful load will be 1,800 kilogrammes, and the speed three metres per second. For lowering, the useful weight can be increased to 3,500 kilogrammes. The skip and accessories weigh 2,000 kilogrammes. The cars, empty, weigh 800 kilogrammes; the cables, 1,286 kilogrammes, and the counterweight, 2,-800 kilogrammes. In order to lift 1,800 kilogrammes 200 effective horse-power is required, falling at the end of the lift to forty horse-power.

Although a steam winding gear was available, electrical control was decided upon in place of steam, in order to avoid the expense of transporting coal. Further, there already existed a three-phase ventilating motor, and the conductors could be used to supply other motors up to an aggregate output of 150 horse-power.

The power station consists of two horizontal compound steam engines with Collmann valves, having low-pressure cylinders seventy centimetres in diameter, and high-pressure cylinders forty-five centimetres in diameter, with a stroke of ninety centimetres. Each machine, at a pressure of eight atmospheres and a speed of 125 revolutions per minute, develops 500 effective horse-power. Directly coupled to the shaft of the flywheel of each engine is a three-phase generator operating at a tension of from 2,080 to 2,300 volts, and developing 300 horse-power. Excitation is secured by means of two transforming groups, one held as a reserve. Each group consists of a shunt dynamo running at 750 revolutions per minute, generating at 125 volts and rated at seventeen kilowatts. Each is coupled directly by a belt to a twenty-horse-power three-phase motor running at the same speed, and supplied at 120 volts. The motor-starting resistance is placed in the rotor.

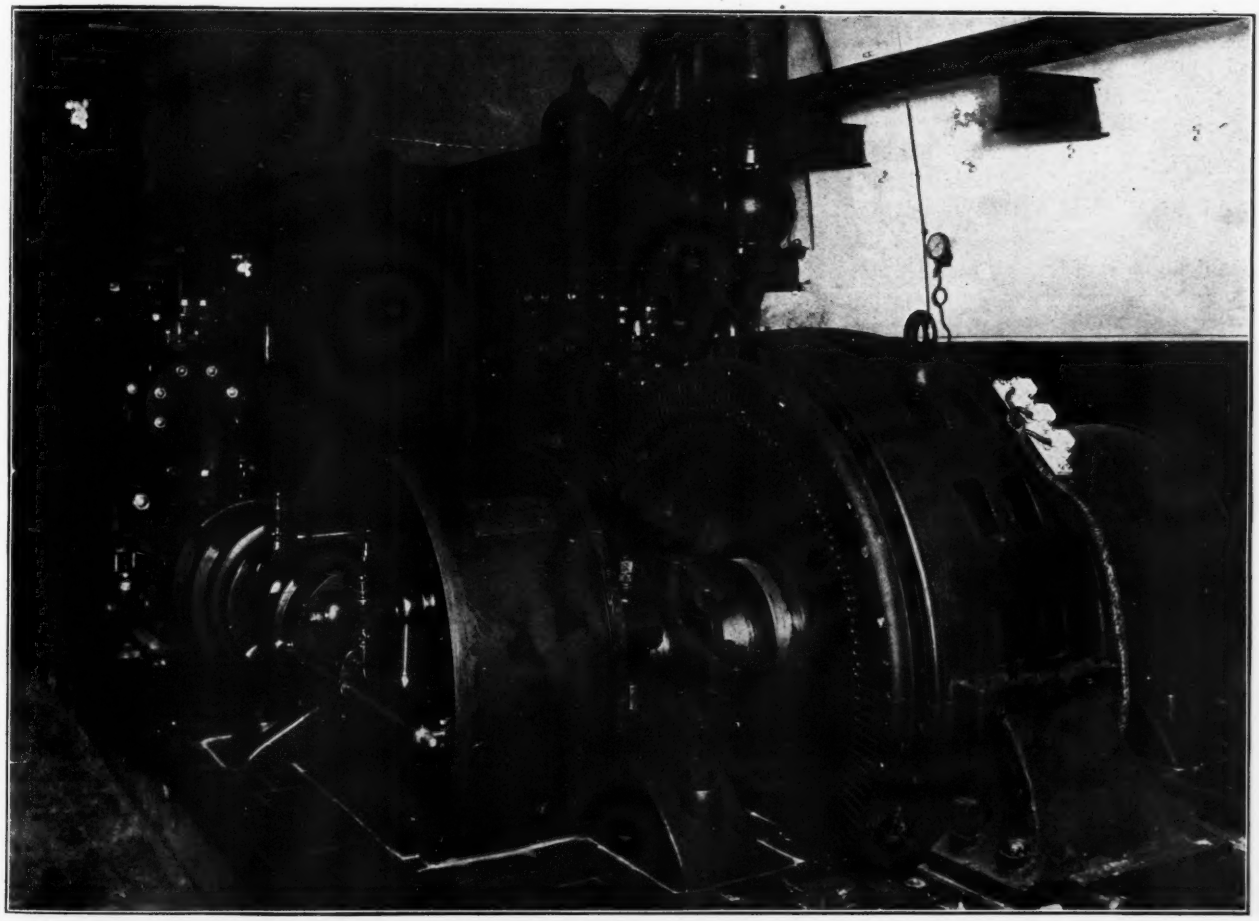


FIG. 4.—SHOWING THREE-PHASE, 160-HORSE-POWER, 2,200-VOLT MOTOR, MOUNTED DIRECTLY ON THE PUMP AXLE, AT THE GERMANIA I MINE.

For transforming current for lighting, for the motors driving the exciters, and for very small motors, there are six single-phase transformers and three-phase transformers with an aggregate output of 298 kilowatts at 2,200 volts primary pressure, and 220 or 110 volts secondary pressure, fifty cycles per second.

The hoisting engine shown in Fig. 5 consists of a fixed drum and a movable drum. The diameter of each is 3.6 metres,

and its length is 1.4 metres. On the end of each shaft is a grooved cylinder 3.6 metres in diameter and thirteen centimetres wide, consisting of many pieces bolted in such a way as to be easily replaced. The brake operates by means of two wooden shoes acting on the sides of these cylinders.

The drum shaft is of cast steel thirty centimetres in diameter, and rests on large bearings. Between the two drums a gear is fixed on the shaft, which is four metres in diameter and has 144 teeth. This engages with a gear 67.2 centimetres in diameter and containing twenty-four teeth. A second pair of gears is placed in a case of sheet iron filled with oil. The gear, which is connected directly to a motor, is 41.6 centimetres in diameter and has twenty-six teeth, while the second gear is 2.08 metres in diameter and has 130 teeth. By virtue of this transmission, the drum shaft has a speed of only sixteen revolutions per minute. The motor, which is in front of the drum, to the left, is a three-phase induction machine with twelve poles. It is rated at 120 horse-power at a speed of 485 revolutions per minute, and its output can be doubled. It is fed directly with current at 2,000 volts. High-tension windings were placed only on the stator, the voltage in the rotor being but 500. The rotor is furnished with slip rings, to allow starting resistance to be introduced. This not only increases the starting torque, but decreases the starting current and raises the power-factor, although it causes some loss, due to the resistance. The starting resistance is composed of coils of wire.

The motor may be operated right-handedly or left-handedly and its speed varied by means of a lever. Braking is effected by two independent brakes, each acting upon a grooved cylinder. The operating brake is actuated by compressed air and is controlled by hand by means of a lever and an auxiliary motor. This brake consists of two cylinders placed side by side, one for air and the other for oil. Each position of the lever corresponds to a definite braking pressure on the shoes. The brake can be maintained in any position and disengaged entirely or lightly at will. Compressed air is furnished by a small compressor, under a pressure of six atmospheres. This is driven by a small three-phase five-horse-power motor, operating at 110 volts.

The safety brake is completely independent of the operating brake. It is controlled by a pedal, or even automatically. Automatic braking takes place when the cage passes the upper station, and is brought about by means of a mechanism which disengages a counter-weight on the brake. Release of the brake —that is to say, lifting of the weight— is accomplished by means of a vertical shaft on the left of the operator, turned by means of a hand-wheel. Simultaneously with disengaging the braking weight, the reversing lever is automatically thrown to the zero position, so that the throwing of the brakes stops the motor at the same instant. Further, in order to start, this lever can not be moved until the brake is released. This connection between the operating lever and the brake is necessary in order to avoid accidents to the motor.

Two parts of the winding engine are mounted on a foundation plate made up of a number of parts bolted together. The switchboard is placed in the machine room, and contains the usual apparatus—fuses, circuit-breakers, etc. In the rear of this is the transformer, and the operator has under his eyes a wattmeter supported on a column.

At full load the efficiency of the motor is ninety-two per cent, and the power-factor is 0.9. The total efficiency should be seventy-two per cent when the installation is completed.

To raise a load, the machinist first disengages the operating brake, then throws the controlling lever. At the end of the hoist he returns the controlling lever to the zero position, throwing the brakes easily. If these do not respond sufficiently, he disengages the safety brake by means of a pedal. To descend, he first disengages the brake, then passes a current through the motor almost equivalent to that taken at normal speed, thus securing electrical braking of the motor, and, at the same time, returning energy to the supply system. This is a distinct advantage secured by electrically driven winding engines. In this way the motor does not exceed the normal speed. Toward the end of the descent the motor is cut out of circuit and the air brake is applied.

One of the greatest advantages of electrical operation of winding machines is their simplicity. The consumption of oil is reduced to a minimum, and a single mechanic suffices for inspection. In its provisional use for sinking shafts, the great ease and smoothness of hoisting are appreciated, as from this point of view this class of apparatus surpasses all steam-driven hoisting engines.

The quantity of steam taken by the engines in the generating station is ten kilogrammes per indicated horse-power per hour. As the efficiency is eighty-five per cent, the consumption of steam is increased per horse-power-hour to twelve kilogrammes. The efficiency of the dynamos is ninety-two per cent, that of the circuit is ninety-two per cent, and that of the hoisting machines is seventy-two per cent, making a total efficiency in round figures of sixty per cent. The consumption of steam per useful horse-power-hour is, therefore, twenty kilogrammes. Allowing for safety twenty-five per cent, the consumption of steam for each effective horse-power per hour of this hoisting machine is twenty-five kilogrammes. After completing the shaft, the useful load of the motor will be 1,000 kilogrammes, which will equal about 100 horse-power. The motor was calculated for 1,800 kilogrammes of useful load, but even then it will not be fully loaded. Under this condition an increase of ten per cent should be allowed for in steam, so that the consumption will be about 2,800 kilogrammes per hour. Under the same conditions, a

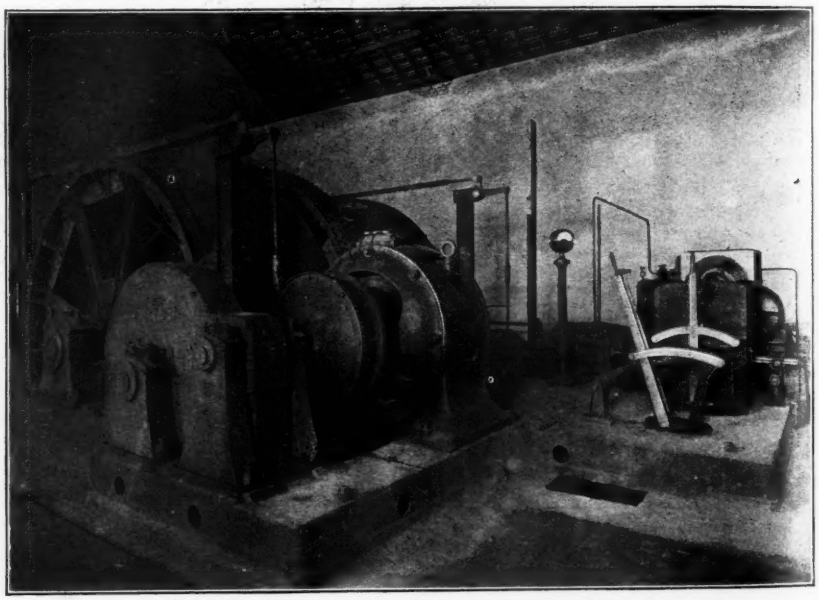


FIG. 5.—SHOWING HOISTING ENGINE, DRIVEN BY THREE-PHASE MOTOR.

steam hoisting equipment would require about 4,500 kilogrammes per hour, so that the economy in favor of electricity is thirty-eight per cent. To produce this quantity of steam per hour, 240 kilogrammes of coal are necessary. The increase in coal due to a steam equipment representing about three francs per hour, and the annual saving in coal effected by electricity would be 10,750 francs ($2,150).

Furthermore, to evaporate 5,000 kilogrammes of steam per hour necessitates 300 square metres of heating surface, say, three boilers costing 45,000 francs ($9,000). These would require the services of two men. On the other hand, the production of steam necessary for the electrical power-house can be secured from two boilers, and would require but one man, thus effecting a saving of fifty per cent in labor. The saving in coal and labor—putting labor at four francs per day—will amount to 12,500 francs ($2,500) per year. If the station under consideration were operated with boilers heated with gas, the expense of fuel would be suppressed and part of that for labor, so that the economy would be further increased.

The cost of the installation does not diminish this favorable result indicated above. This expense is 37,500 francs ($7,500) in all, amounting, with the cable, to 47,500 francs ($9,500). A steam winding engine, including the boilers, would cost, under the same conditions, 80,000 francs ($16,000). The difference in favor of electricity is then 32,500 francs ($6,500). A part of the cost of the generating station should be charged to the winding engine. This part is easily compensated for by this 32,500 francs saved. The result in the case considered shows that the expense of an electrically operated winding engine is not greater than it would have been for the steam equipment, while the performance is very much better.

This installation shows, in a general way, that it is easy to install an electrical winding engine in ventilating shafts where an electrical ventilator is already provided; that the cost of this installation will not be greater than that of a steam machine, and that the cost of operation will be small.

It is possible to obtain similar results when using electrical winding for digging galleries, the figures to be taken into consideration being almost the same; and the cost of coal for the steam installation is further increased by the difficulty of supplying it at the work.

Besides the installations described, the Hélios Company has carried out many others, large and small, to describe which would increase considerably the length of this article. Sufficient has been said to show that the mining work of the Hélios Company is large, important and interesting. In this field, as in many others, this company is possibly the first on the Continent as regards the practicability of its installations and the incessant efforts put forth toward perfection.

The Civil Engineers and the Carnegie Gift.

The American Society of Civil Engineers, through a ballot vote taken recently, has decided not to join with the other national engineering bodies of the country in accepting Mr. Andrew Carnegie's gift of $1,500,000 for an engineering home in New York city. There were 1,134 votes against acceptance, and 662 for acceptance, or a majority of 472 against the plan.

Following the library dinner of the American Institute of Electrical Engineers, held in February of last year, Mr. Carnegie gave $1,000,000 to the four principal national engineering societies—the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers. There was also included the Engineers' Club, a social organization, the members of which are also members of the other engineering societies. This money was to be devoted to the erection of a building, or buildings, where all of these bodies could be properly housed. Up to the present time there has been about $600,000 spent in acquiring the most convenient sites for the location of this union building. Within a short time three of the engineering bodies and the Engineers' Club decided to accept this gift, the civil engineers being the only ones not deciding immediately. When plans were more fully formulated, it was seen that the building would have to accommodate at least 12,000 members, if the present rate of growth were only partially kept up. Mr. Carnegie then subscribed an additional $500,000, making his total subscription $1,500,000. The ultimate adjustment of this matter, now that the civils have decided to stay out of the union, will be watched with the deepest interest by engineers throughout the world.

The Meeting of the Michigan Independent Telephone Association.

At the meeting of the Michigan Independent Telephone Association, held in Grand Rapids, Mich., on February 25 and 26, the following officers were elected: president, F. B. Fisher, Grand Rapids; vice-president, R. B. McPherson, Howell; secretary, C. F. Brown, Alma; treasurer, R. F. Johnson, Saginaw.

Other members of the executive committee are William Robertson, Muskegon; W. O. Hunt, Adrian; J. Robertson, Benton Harbor; A. E. Palmer, Kalkaska; W. E. Wing, Grass Lake.

Analogies between Radioactivity and the Behavior of Ozone.

A brief account is given in *Nature* of some recent work by Herren Richarz and Schenck, of the Prussian Academy, which directs attention to the striking analogies between radioactivity and the behavior of ozone. Freshly prepared ozone, and ozone that has been decomposed by deozonizers, have the power of causing condensation in a steam jet and imparting conductivity to the air in a similar manner to those metallic salts which emit Becquerel radiations. Photographic effects have also been observed, but the ozone does not act upon all the fluorescent screens. It causes hexagonal zinc blende to fluoresce, but it does not affect zinc oxide. This is regarded as evidence that massive ions are produced, comparable to the X-rays of radium. Platinum that has been in contact with ozone exhibits reduced radioactivity. It is suggested that the slight conductivity normally observed in the atmosphere, and certain of the effects produced by radioactive bodies, may perhaps be due to the formation and decomposition of ozone or hydrogen peroxide.

The Faraday Society.

A meeting of the Faraday Society—which is the English association devoted to the interests of electrochemistry and electrometallurgy—was held on February 2, when an abstract of a paper by Mr. S. O. Cowper-Coles, entitled "Notes on the Welding of Aluminum," was read and discussed. The operation consists simply in bringing the aluminum to a point of fusion by means of a benzine flame, and then forcing the two parts together. The surface coating, which consists largely of the oxide, is squeezed out, the metal flows together and forms a complete weld.

A paper by Mr. M. Hollard, entitled "Some Applications of the Theory of Electrolysis to the Separation of Metals from One Another," was also read. This paper appeared in full in the issue of the ELECTRICAL REVIEW of Februarv 27.

Action of Radium Bromide on the Electrical Resistance of Bismuth.

M. R. Piellot has examined the action of radium bromide upon a spiral of bismuth. He found that the radiations diminish the electrical resistance of bismuth. The effect is constant and instantaneous, and varies with the distance of the active material from the surface of the bismuth. Interposing a screen between the salt and the bismuth eliminates the effect.

THE GAS ENGINE FOR CENTRAL STATION SERVICE.[1]

BY RALPH D. MERSHON.

It has been my pleasure recently to make an investigation of the state of the gas engine art. The investigation was made not so much with reference to the matter of design as to the general engineering aspect of the gas engine question —as to what had been and could be accomplished by means of this form of prime mover. It was undertaken in order to make a report relative to the use of gas engines in large central stations, and in the course of it most of the large gas installations in this country and abroad were visited, as were also the large manufactories of gas engines.

One could not at first thought consider the gas engine as being a hot air engine, but that is what it is. You are no doubt familiar in a general way with the work which has been done in the past, especially by John Ericsson, in the endeavor to make the hot air engine a success, and of the failure to do so in large sizes. The difference between the gas engine and the hot air engine lies in the manner of applying the heat to air which forms the working fluid of the engine, and as a result the very things which made the hot air engine a failure make the gas engine a success. In the hot air engine the working fluid is heated by a furnace, and this is where the main difficulty lies. Air is a poor conductor of heat and does not absorb heat rapidly, even by convection. It is very difficult, therefore, to heat air rapidly in the furnace, and the high temperatures necessary in the furnace itself in order to achieve any measure of success result in rapid deterioration. In addition, because of the comparatively low temperature which can be attained in the air, hot air engines are necessarily very bulky, which besides its other disadvantages results in low mechanical efficiency. In the gas engine, however, the furnace is the cylinder of the engine itself. The working fluid, the air, is first intimately mixed with the fuel, the gas, and combustion is made to take place in the cylinder of the engine. The result is that instead of having to get heat into the air by conduction or convection the heat itself is generated in the air, so that the generation and distribution of the heat are coincident, and independent of the conductivity of the air itself. The low heat conductivity of air becomes in this case an advantage instead of a disadvantage in that it prevents the rapid escape of heat to the walls of the gas engine cylinder. Nevertheless there is a considerable escape and in order to keep the temperature of the cylinder walls down to a point which will allow of proper lubrication the cylinder is cooled by a water jacket outside of it. Indeed, in large gas engines, not only is the cylinder cooled by water circulation but the pistons and exhaust valves are cooled in a like manner.

(The author took up in detail the fundamental principles of gas engine operation. He described at length the cycle of Beau de Rochas, carefully demonstrating the utility and service of the four-stroke engine. He mentioned the different methods of igniting the explosive charge, and the function of compression in this class of machinery. The construction and operation of the two-stroke engine were then taken up, and the action of this machine carefully explained. In describing the action of the two-stroke engine, the author called particular attention to the Oechelhauser apparatus. This machine has neither admission valves nor exhaust valves. The engine has two pistons moving in opposite directions in the same cylinder. The forward piston has a connecting rod to a crank on the main shaft, while the rear piston has connecting rods to two cranks on the main shaft, on either side of the first crank and 180 degrees from it. In this engine the gas and air are thoroughly mixed before being admitted to the cylinder, instead of being mixed during admission. The air and gas are compressed in a separate pump, driven by an extension of the main piston rod. The methods of governing gas engines, both of the two-stroke and four-stroke types, were taken up in detail and a comparison made of the methods of governing. These were shown to be by causing the engines to miss one or more working strokes by cutting down on the ignition and using a heavy flywheel, and that of varying the mixture admitted to the cylinders, at the same time endeavoring to keep its quality constant. The gas generators employed in connection with gas engines of various types were described. The chemical reactions taking place were explained, and particular attention was called to the designs of the Julius Pintsch Company, of Berlin, Germany.)

Returning again to the question of the engine, one of the first points which arises when considering it for electrical work is that of the operation in parallel of direct-driven generators. With generators for supplying direct current the problem is comparatively simple, since it depends principally upon the action of the governors of the various engines and is not very difficult of solution. With alternators, however, there is a further question of the angular variation in the rotative effort of the engines due to the impulses on the piston. Most of you are conversant with this problem as involved in connection with the steam engine, but in the case of the gas engine the solution is not quite so easily arrived at. In the case of a single-acting four-stroke engine giving an impulse for only one stroke in every four, it is very evident that in order to obtain a sufficiently uniform rotative effort a much heavier flywheel will be required than in the case of an engine giving an impulse every stroke. In order to keep down the weight of the flywheel required, various expedients have been resorted to. One of these is to use in one engine a number of single-acting cylinders, each acting upon its own crank and so arranged as to give a rotative effort as uniform as possible. In order to accomplish this to the best advantage, as will be seen later on, pairs of cylinders should be arranged facing each other, although they are sometimes arranged in tandem and sometimes side by side. We will not give much consideration to this use of single-acting cylinders, however, for the reason that the present tendency, especially in large engines, is to make them double-acting, and to arrange the cylinders in tandem in such a way as to produce an impulse for every stroke of the engine. The method of making the two-stroke engine double-acting has already been described. In it an impulse may be obtained at every stroke by means of what is in effect a single cylinder. But in the case of the four-stroke engine it is necessary, in order to obtain an impulse every stroke, to not only employ a double-acting cylinder, but to employ two such cylinders in tandem. Remembering that on each side of this piston there can only be one impulse for each four strokes, and following the cycle of operation for each side of the piston we see that in the system illustrated there will be two impulses for every four strokes and that these impulses will come one immediately after the other, so that in operation we shall have two impulses in succession, then two idle strokes, then two impulses in succession again, and so on. This sequence of impulses will require a heavier flywheel than though there were an impulse every other stroke, and will

[1] Read before the New York Electrical Society, February 17, 1904. Abstracted and abridged.

require a considerably heavier flywheel than though there were an impulse every stroke. In order, therefore, to obtain a still more uniform effect, two cylinders are generally combined in a tandem. This arrangement gives an impulse every stroke. The present tendency of gas engine design for electrical work is toward the arrangement shown in the last figure, and in many cases two such systems as that shown are employed, each being connected to its own crank, the cranks being approximately ninety degrees apart. In using the term flywheel in connection with the question of equalizing the rotating effort, the work must be considered as designating not simply the rotating masses of the engine, but all moving masses which will serve for the storage and the giving out again of energy. This will include the reciprocating parts of the engines, or, as it is sometimes termed, the reciprocating flywheel. The reciprocating flywheel is of even more importance in the double-acting gas engine of the character described than in the steam engine, for the reason that in the former, because of the high compression employed, it is possible to use greater reciprocating masses and therefore provide for considerably greater storage of energy in them.

By making use of the two double-acting four-stroke cylinders as described, or one of the double-acting two-stroke cylinders described some time previously, it is possible to obtain the required uniformity of rotative effort for the proper paralleling alternators, and the result may be accomplished without excessive weight in the flywheel or reciprocating parts.

The cost of the gas engine is considerably in excess of that of the steam engine, and as compared with the steam turbine the discrepancy is even greater. There is a point of difference between the steam prime movers and the gas engine which further exaggerates any relative cost which may be given per horse-power. The steam turbine and steam engine have a certain amount of overload capacity. That is to say, they are capable of operating, though at somewhat impaired efficiency, at loads considerably in excess of their rated output, or the output at which they give the best performance. The gas engine, however, has, properly, no overload capacity. Its performance improves up to the point where it can not carry any further load and at which any further loading causes it to slow down. This is not strictly true for engines of the two-stroke type, which have a slight overload capacity beyond the point of best performance, but this overload capacity does not exceed twenty per cent of the rated capacity and is probably less. With the four-stroke engine, however, the statement as regards overloads holds. It is necessary, then, in purchasing gas engines to provide for a rated capacity approximately equal to the overload which will have to be carried at any time, so that the comparison of prices on the basis of the cost per horse-power does not always give a correct idea of the relative costs, because in the case of the gas engine we must provide for a greater total number of rated horse-power. The quoted prices on the gas engines in this country at the present time vary quite surprisingly. Depending upon the maker quoting, the prices on a horse-power basis range from sixty per cent greater than for a steam engine to over twice the steam engine figures. In comparing the gas engine with the steam turbine prices we find a still greater discrepancy. In order to make the comparison, it is necessary to add to the cost of the gas engine the price of a suitable alternator, since the steam turbines are always furnished with the alternator which they drive. If this is done it will result in a cost per kilowatt of output at least twice as great in the case of the gas engine as in the case of the steam turbine, and if the comparison be made on the basis of a suitable overload capacity, the discrepancy will be even greater.

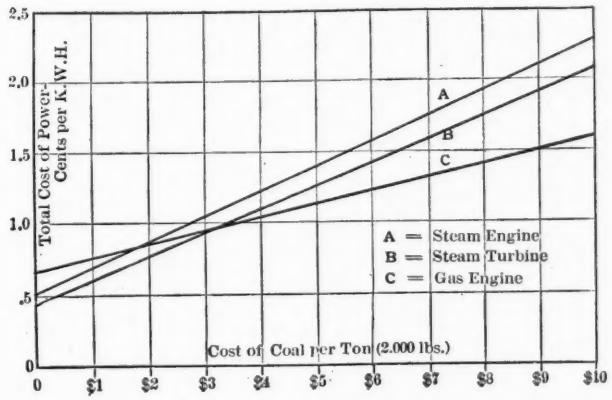


FIG. 1.—COMPARATIVE DATA.

The cost of the gas generating plant for use in connection with the gas engine may be taken as being about twice the cost of the steam boilers necessary for use in connection with a steam prime mover. This is for a simple gas generator and cleaning plant, without any installation for the production of by-products.

It will be seen, therefore, that the cost of a gas engine plant, including the necessary gas generator, is considerably in excess of the cost of steam plant for the same service, especially if the steam prime movers be turbines. The cost of maintenance and the figure which must be taken for depreciation on such plants is therefore correspondingly higher, and the cost of the attendance is also greater, since it requires a somewhat better class of men to handle a gas plant. On the other hand, the efficiency of the gas plant is very much better than that of the steam plant, the gas plant requiring for the same service about half the coal required by the steam engine plant and a little more than half that required by the steam turbine plant.

In order to give you an idea as to the relative costs of electric power by the three types of plant, and the influence that the cost of fuel has upon the cost of power, I have prepared some figures for a steam engine plant, a steam turbine plant, and a gas engine plant for the same service. In these figures I have included everything properly chargeable against the cost of power.

It is assumed in each case that current is to be supplied to a load having a load-factor of 0.5 and that the peak load is 1,500 kilowatts. It is assumed that this load will be carried by four generators having a rated capacity of 400 kilowatts each and operating when necessary at twenty-five per cent overload. The generators to be cut in and out of service in such a way that the average efficiency of each unit will be the same as though it ran continuously at seventy-five per cent of its rated capacity. The thermal value of the coal is taken as 12,500 British thermal units per pound, and it is assumed that this coal will evaporate seven pounds of steam when burned under the boilers, and when used in the gas generators will produce gas having a total thermal value of 10,000 British thermal units. It is assumed that a steam pressure of 150 pounds is to be

used and that the steam is to be superheated to 150 degrees Fahrenheit above its normal temperature. Under these conditions the following figures for performance are taken, being such as will be guaranteed by the makers of the various pieces of apparatus:

Steam engine, twelve pounds per brake horse-power-hour.

Steam turbine, eighteen pounds per kilowatt-hour.

Gas engine, 10,000 British thermal units per brake horse-power-hour.

Suitable modifications of these values were made to take care of the fact that the units are to run at seventy-five per cent of their rating capacity and to take care of condensation and auxiliaries in the case of the steam plants. Making use of these figures in connection with the costs necessary for such estimates, there were obtained the results embodied in the curves in Fig. 1. It is to be understood that these curves include everything properly chargeable against the cost of power, including interest, depreciation and renewals on the whole installation and supplies, labor and fuel. The line *a* shows the cost for a steam engine plant, *b* for a steam turbine plant, and *c* for a gas engine plant. The slope of these lines shows in each case the increase in power cost as the cost of the fuel increases. The point at which the line *c* crosses the other two lines shows the cost of fuel at which the gas engine plant is on a parity with the steam engine plant and the steam turbine respectively as regards the total cost of power. These curves give us an idea, therefore, of the cost of fuel at which it would begin to pay, under the present prices for apparatus, to install a gas engine plant rather than a steam plant. As will be seen from the curves, the gas engine plant and the steam engine are at a parity with coal costing about $1.85, while the point of equality with respect to the steam turbine plant is with coal at about $3. It is believed that these curves show the relative performance of such plants under the condition assumed pretty fairly, no matter what modifications might be made in the estimates, since while the modifications might change to some extent the actual value for the cost of power, the relative value will not be much changed by a modification common to all of the plants. It should be borne in mind also that these figures are made on the assumption of a load having a load-factor of 0.5, and that for more continuous service the gas engine will make a much better showing. It should also be borne in mind that these estimates are made without reference to any recovery of by-products, and that such recovery would very materially alter the showing made.

An inspection of these curves at the point where the value of the fuel is zero shows very plainly that if, as it has sometimes been proposed to do, plants be installed at coal mines for the generation of power, a steam turbine and not a gas engine plant should be used unless a plant for the recovery of by-products be made a part of the installation.

The relative values here arrived at will no doubt have to be changed with the progress in the gas engine art. The gas engine equipment will become cheaper as its use becomes more general, and this, in connection with the fact that some hard work is being done in the endeavor to produce a gas turbine, makes me think we may look forward to a time not far off when gas prime movers of some sort will be installed instead of steam prime movers.

Acknowledgments for some of the illustrations reproduced herewith from their literature on the subject, should be made to Mr. Wilhelm von Oechelhauser, general director of the German Continental Gas Company; Mr. H. Gerdes, chief engineer of Julius Pintsch, Berlin; Allis-Chalmers Company, Chicago, in regard to the Nurnberg gas engine, and Korting Brothers, Limited, of London.

EUROPEAN PRACTICE IN THE CONSTRUCTION AND OPERATION OF HIGH-PRESSURE TRANSMISSION LINES AND INSULATORS.[1]

BY GUIDO SEMENZA.

In Europe, as in America, the old practice in overhead line construction has always been to consider the construction of an electric transmission line, work that any man could do. It was sufficient to erect a number of wooden poles, fix on them some insulators and stretch some wires, and everything was expected to work well. The line was considered the simplest and the easiest part of the plant. It is true, on the contrary, that the line was the part which gave the greatest trouble; but the line constructors placed the blame upon atmospheric disturbances. It was only at the time of the Paderno (Italy) installation in 1895, I believe, that new views were entertained on this problem.

The new way of considering the matter, originally due to Mr. Roethlisberger, an engineer of great skill in metal frame constructions, was the following: An electric transmission line, being a structure every part of which has to bear certain strains, must come under the general head of engineering work, as would any similar structure.

Following this principle, new solutions and views were gradually entertained, and the different matters treated of in this paper are to be considered the result of a study of the subject by many engineers.

The first question which requires consideration when a line is to be built and the voltage of the current has been fixed, is; which is the most advantageous wire section to be adopted?

The greater the weight of copper, the less the loss; so that by increasing the wire section we incur a larger outlay of capital and annual fixed charge in order to increase the possible income. But, while the income as a function of the copper loss follows a linear law of variation, the outlay of capital follows a hyperbolic law. Supposing, then, that the following values are known; namely, power produced; cost of installation; selling price; operating expenses; the value of the copper loss which will bring a maximum profit can be found.

On the contrary, when the selling price is not fixed, the value of the copper loss which reduces to a minimum the annual cost per kilowatt utilized may be the quantity to be determined.

These problems may be worked out in an analytical way by writing down the equations and solving them by the differential calculus. But it is much better to draw the curves of the different elements and compare them.

In Europe, generally speaking, important lines are carried across the country and not alongside roads; this is done for obvious reasons. The cross-country method allows the building of a straight line, thus avoiding angles to a considerable extent; then, again, the line is shorter. Of course, crossing cultivated land, as is generally the case in Europe, the cost of building the line is increased on account of the expropriations; but in the greater number of cases, the extra cost of purchase of land or of right of way is more than compensated by the shorter line.

The principal reason for the adoption of wooden poles is the small cost of installation. For small lines this may be true. Another reason is the assumption that wooden poles increase the insulation of the line; and this also is true, but only when the insulators are very bad. A close investigation, however, will lessen the advantages claimed for wooden poles.

The first iron poles erected for transmission lines were very heavy. While no calculations were made for lines with wooden poles, it was expected that iron poles should stand, even with all the wires broken down on one side of them. This was an excessive requirement and not in

[1] A paper presented at the 184th meeting of the American Institute of Electrical Engineers, New York, February 26, 1904. Abridged.

the least justified. In subsequent line construction the hypothesis was accepted that iron poles should stand with one or two wires broken. Lighter poles could then be used. It was then possible to increase the spans, previously limited to 100 feet, to 200 feet, and later on to 250 feet; and at the present time some lines are constructed with spans ranging from 300 to 400 feet.

The iron poles employed are generally constructed of latticework with a square base. They possess the same resistance in the direction of the line as across the line, and they can resist the strains in any direction.

When more than two wires in a single-phase system, or more than three wires in a three-phase system are to be used, it may be found convenient to separate the wires into two lines, in order to render possible the repairing of wires on one side while the others are in circuit. In this case the support is formed of two poles placed apart and joined by cross-connections. On straight lines with equal spans, the only strain to be borne by the line is exerted by the wind. In this case it is useless to employ poles of equal resistance in all directions. A line support designed on these considerations is constructed with two U-shaped irons, cross-connected with angle irons. It carries six wires divided into two sets, two metres, 6.5 feet, apart. Having a very wide base, it presents a great resistance in the direction of the wind and a low resistance in the direction of the line, in which direction it is elastic and can deflect over sixteen inches without exceeding the limit of elasticity, and is called the "elastic support."

ADVANTAGES.

Wooden poles will last from two to ten years, according to the nature of the ground. The durability of iron poles can not be definitely stated as yet, but they will surely last forty years, reducing the depreciation to a small amount.

Spans with iron poles may reach from 300 to 400 feet and in exceptional cases to 600 feet and more.

The experience with existing lines constructed with iron poles, shows that the expense of keeping the line in proper repair and good working condition is very much reduced.

The following figures show the difference in cost between a line constructed with wooden poles and a line constructed with iron poles, based upon European prices and for a three-wire line for high-tension transmission:

WOODEN POLES.

53 poles at $6	$318
3x53=159 insulators with brackets, at $1	159
For right of land occupation, $2 per pole	106
	$583

IRON POLES.

16 poles at $24	$384
Concrete foundation at $9	144
3x16=48 insulators with brackets, at $1.	48
For right of land occupation, $2 per pole	32
	$608

We shall now proceed with the consideration of the best method to be pursued in the construction of a line, more especially with reference to important lines. When the land across which the line is to be constructed has been decided upon, a careful survey is made and a map drawn, on which the location of each pole is marked, the angles and eventually the prescribed height of the lowest wire from the ground. The single supports are then studied and calculated. These are divided into two classes; namely, normal and special. The normal supports are intended for small angles, equal spans and normal height. The special supports are those which have to meet special conditions.

Wooden cross-arms are sometimes employed with iron poles, in which case any system of pins may be used; but, in general, supports constructed entirely of iron are preferable. In this case either iron or steel pins are used on brackets composed of an angle iron, or even entirely of cast steel.

A special cement is employed to fasten the insulators to these brackets, or, in the case of small lines, tarred rope is employed. The best cement that can be employed for this purpose is composed of ten parts of litharge and one of glycerine, well mixed. In a cemented insulator the pressure between pin and porcelain is equally distributed over a large surface; while with the threaded-pin system, a slight bending causes the insulator to break, as it will in this case press against one point of the pin. The author has often tested insulators cemented on 1.5-inch rods, and always succeeded in bending the rods without breaking the porcelain.

When the span exceeds a certain length, care must be taken that the wires do not come in contact through their oscillation due to the wind. Two or more wires should never be placed on the same level, and the adoption of cross-arms as practised in America is not to be followed.

In order to reach a high economy in the use of iron poles, it is necessary to put in them only the quantity of iron that is absolutely necessary; and this can not be done without a close calculation of every element of the line. The author had the opportunity of calculating the poles of a line built without much precaution, and found that each pole weighed about 200 pounds more than was necessary. As the number of poles was 600, the extra weight represented a total of about sixty tons of metal in excess of what was actually necessary.

Glass insulators are not used in Europe, and the reason for this is that good porcelain can readily be obtained there. Glass is considered to have a better dielectric strength, but not as good surface insulation; moreover, glass is weaker against meteorological agencies, the superiority of porcelain being due to the materials composing the glazing.

It is the general practice to examine all insulators on their arrival from the factory and put aside such as present a bad appearance; such as are not glazed all over the surface, or have cracks, spots, etc. In Europe insulators may be obtained quite perfectly finished. It is considered necessary that the head and all external parts should be thoroughly glazed; to ensure this they are supported from the bottom in the baking process.

In designing an insulator the following points are to be considered: dielectric resistance; resistance against surface arcing; mechanical strength; facility of cleaning; ease of construction.

The first two points have reference to electrical qualities and an ideal insulator ought to be so proportioned that, under a certain voltage, it should break in both ways, by puncture and by surface arcing. It is well known how the resistance against puncture can be increased, by making the insulators of several pieces, introduced one piece inside the other. In general, the different pieces are cemented together with a kind of glazing in the process of manufacture and put on the market as single pieces.

The author does not follow this practice, but prefers having them furnished by the factory in separate pieces, for the following reason: when the thickness of the porcelain reaches a certain limit, the ordinary testing will not puncture a sound insulator. In testing an insulator made up of two or more pieces, one layer of porcelain may be cracked but is protected by the other layers. When the tests are performed on the single composing parts, this can not happen, and one is sure to have the insulators made up of sound parts. Moreover, each composing part can be better inspected and the character of glazing observed. Following this suggestion many factories produce insulators in two parts, which after test are put together with glycerine and litharge cement. Experience has demonstrated that it is useless to increase the number of component parts; up to 40,000 volts two parts are quite sufficient and above that voltage not more than three are necessary.

The ability of an insulator to resist surface arcing is due to its dimensions and shape, the latter to be considered under a double aspect: 1. The protective action against moisture and rain. 2. The property of giving origin to electrostatic phenomena. An insulator with a very large petticoat on the top and only a second petticoat round the pin will not afford a very good protection against rain and moisture, as during a storm the inner petticoat will get quite wet. It is therefore good practice to have one or two intermediate petticoats, which will also ensure the dryness of some part of the surface in all kinds of weather. Care must, however, be taken not to put on too many of them, as their edges would come too near, thus forming a good path for the arc, besides increasing the difficulty of cleaning the insulator.

Reviews of Current Engineering and Scientific Literature.

The Selenium Cell for the Phototelephone.

In a short review of phototelephony, Mr. Shelford Bidwell describes the construction of the selenium cells used by Rühmer. These are of the pattern proposed by the author in 1880. Two thin wires, serving as electrodes, are wound spirally very close together, but not touching, around a cylinder of unglazed porcelain, upon which a fine double screw thread has been formed. The surface of this cylinder is covered with a thin coating of selenium, which is afterward crystallized. It is important to produce the crystallization in the proper way, which consists in raising the selenium to a temperature somewhat above 100 degrees centigrade, and letting it gradually cool down. This method causes a fine crystallization. If the selenium is melted at about 250 degrees, and then cooled, the crystallization is coarser, and the cell is less affected, as regards conductivity, by changes from darkness to light. Rühmer, however, says that the coarse selenium is much more sensitive to small changes of illumination, and responds to such changes more quickly. It is advantageous to enclose the selenium cell in an exhausted glass globe. The author describes the Rühmer system, and says that the apparatus is now being manufactured commercially in Germany. —*Abstracted from Nature (London), February* 18.

New Telephone Equipment at the Berlin Exchange No. 4.

In this brief article M. Emile Guarini describes the new Siemens-Schuckert telephone switchboard installed at the No. 4 exchange in Berlin. This is equipped with the multiple switching system and serves 14,000 stations. The cables passing in from under the street to the basement of the building are fanned out on distributing boards at this point by means of an iron frame supporting vertical parallel strips of wood upon which are arranged double rows of terminals. Each pair of terminals forms the extremities of one subscriber's wire, and from this point the wires are carried up to the switchboard. This is of the horizontal table pattern, the wires being brought up below the table, the operators sitting on both sides. There are, in all, twenty-seven of these tables, arranged within the room in four groups. The services of 162 operators are required in the daytime, each operator caring for 100 stations. At night but two operators are necessary, and to enable them to locate any calling station, each table is provided with an incandescent lamp which is lighted whenever a call is sent to that point, and a bell is rung at the same time. This board, which is one of the largest in Europe, was installed in a space of five months and seven days. It contains 1,500,000 soldered joints.—*Translated and abstracted from Electro (Brussels), January.*

Electrophysical Research.

In this short review Mr. G. W. de Tunzelmann sums up some of the most recent phenomena observed in electrophysics. The most salient feature at the present time is the tendency toward unification. During the early portion of the last century, the tendency was toward increasing specialization. Much data were accumulated, but general theories were comparatively few. The theory of the conservation of energy led to generalization of thermodynamics and to Maxwell's exposition of the theories of the electromagnetic field; but the latter's work was not appreciated until Hertz's experiments. The electro theory now promises the most far-reaching results. It used to be held that matter was something simple and comprehensible in comparison with the unknown entity called electricity. Now physicists have learned to regard the ocean of ether as the ultimate simplest entity. The positive and negative electrons are considered to be the simplest kind of singularity, of differentiation from the surrounding ether, that can possibly exist, and very possibly, not differing from one another. Material atoms may be regarded as complex structures built up of alternate layers of positive and negative electrons, and the external layer consists entirely of negative electrons. No passage of the electron takes place from one layer to another, except when the atom is undergoing disintegration, and while the disintegration of but one element has been demonstrated, it seems probable that this is going on in all matter. Every atom must have some maximum life period, which will be greater the smaller its radioactivity; and it seems possible that the insurmountable barrier which was formerly supposed to exist between living and non-living matter is nothing more substantial than a dark cloud which has hitherto obscured our vision of the borderland.—*Abstracted from the Electrical Magazine (London), January.*

Unbalanced Attraction of the Rotor of Induction Motors.

Several formulæ have been offered by different designers for computing the unbalanced attraction of the rotor of induction motors, due to eccentricity. In the case of this type of apparatus, the air-gap is kept small, in order that a fair power-factor may be obtained; and, for this reason, small errors in centering the rotor may unbalance considerably the magnetic forces. M. Jean Rey has compared the results obtained by using the several formulæ suggested, and found considerable variation. He then attacked the problem himself, and in this paper gives his method and the resulting formula. This has the form $F = \frac{1}{8\ \pi\ 2} B^2 S f(e)$, where F is the unbalanced force of attraction, B the mean value of the inductance in the air-gap, S the surface of the rotor, and $f(e)$ a function depending upon the ratio of the eccentricity to the length of the air-gap. A table of values for this is given, showing that where the ratio is 0.05, the value of this function is 0.129. Where the ratio is 0.2, the function is 0.542. At a ratio of 0.4, the function is 1.348. The application of this formula is illustrated by two examples. The first case assumed is that of a 250-horse-power motor having two poles, and revolving at 1,460 turns per minute. If the air-gap is two millimetres, with an eccentricity of 0.1 millimetre, the unbalanced force is 250 kilogrammes. With an eccentricity of one millimetre, the unbalanced force would be 3,910 kilogrammes. The other case is that of a fifty-horse-power motor with an air-gap of 1.4 millimetres. With an eccentricity of ten per cent, the unbalanced force would be 120 kilogrammes, and with an eccentricity of twenty per cent, 255 kilogrammes. These figures show that the unbalanced force due to eccentricity may be considerable, and that it should be allowed for in calculating the shaft and bearings of the motor.—*Translated and abstracted from L' Éclairage Electrique (Paris), February* 20.

The Electrical Engineering Laboratory at Northampton Institute, England.

In this description of the Northampton Institute, one of the important technical schools of England, a detailed account is given of the equipment of the electrical laboratory. The laboratory is situated close to the power-house, and is divided into two parts, the first containing the general equipment, and the other devoted to the standardizing apparatus. In the main laboratory all machines are bolted to slide rails, which, in turn, rest on other rails embedded in the floor. These machines can be moved from point to point, placed in any position, and immediately secured. All conductors are carried in ducts under the floor from the machines to a main mercury distribution board. The machines are not connected permanently in position, as it is desirable to have the students obtain some experience in making connections; and all facilities are provided for doing this quickly, so that there may be little time wasted. Each machine is fitted with a permanently connected ammeter and voltmeter, and, in most cases, with a shunt regulating resistance and a shunt circuit ammeter. Each machine is, in addition, provided with a special electrical speed indicator, consisting of a copper plate running between the poles of a strong permanent magnet. Contacts are made at the centre and the circumference, and readings are taken on a galvanometer placed beside the other instruments. The largest machines are two ten-kilowatt synchronous converters, which may be operated singly or run in parallel. In the latter case they are coupled by means of a magnetic clutch. The standardizing laboratory is fitted with Kelvin balances, Siemens dynamometers, potentiometers and other necessary apparatus. From this room checking circuits are carried to the several machine boards, and by throwing to a switch, any instrument may be compared with the standard at any time—*Abstracted from Engineering (London), February* 19.

Electro-Capillarity.

A study of electro-capillarity has been made by Herr C. Christiansen, and a summary of his work is here given. The first investigation was carried out with globules of mercury, placed within a small vessel and submerged in the electrode. These take a spherical form until a current is passed. At low values of the current, the globule is distorted into a pear shape, the larger end being pointed in the direction of the flow of current. The explanation offered for this is as follows: a "double layer" is formed at the surface of the mercury when in contact with the electrolyte, the mercury being polarized positively. The distribution of this layer is disturbed by the passage of the current, resulting in a difference of surface tension at the two sides of the globule. Upon an increase of current, the difference becomes more marked, and the sharper end of the globule becomes ridged, and takes a mushroom shape. At the same time, the surface of the mercury moves against the flow of current, while the globule, as a whole, moves with it. To explain this it is assumed that the polarization due to the electrolyte, and that due to the passage of the current, are just balanced at the point where the ridge appears, and at this point the surface tension is a maximum. A further increase in the current makes the phenomena more marked, until finally the globule is divided into two parts, which sometimes repel each other with considerable force. To study the translation of mercury globules, one was placed in a small tube, connected to larger vessels containing the electrolyte. Current was passed through this, and the tube tilted until the force of gravity balanced that due to the current. Different solutions were found to cause the globule to move in different directions. In some cases the direction of translation was reversed by an increase in the current. Falling globules were also studied, by allowing these to drop from a glass nozzle through an electrolyte in which current was passing. These were found to be deflected one way or the other, according to the direction of the current flow, and depending upon the nature of the electrolyte. Amalgams were also studied, the presence of other metals causing marked effects. Dipping a zinc rod into the mercury changed the direction of deflection of the drops.—*Abstracted from the Electrical Review (London), February* 19.

The American River Electric Company's Station on the South Fork of the American River.

The power plant of the American River Electric Company is located on the south fork of the American river, four miles north of Placerville, and distant eighty miles from Stockton and thirty miles from Folsom, to both of which points separate lines are carried. There is also a short local line feeding Placerville. The dam is situated seven miles above the power-house. The water is conducted nearly all the way by a flume. This is six feet in width and is planked at present four feet high, provision being made for increasing this to six feet. The grade is one foot in a thousand. There are two creeks flowing into the ditch two miles above the power-house, which in winter will supply sufficient water to run the entire plant, and thus allow repairs to be made to the principal part of the flume and the dam. The maximum static head of water is 575 feet. The power-house is constructed of concrete, and is provided with a hand-operated twenty-ton crane, two Westinghouse three-phase, 1,500 kilowatt, sixty-cycle, 2,200-volt, engine-type generators, directly coupled to a double water-wheel unit of the Pelton type, rated at 3,000 horse-power, and equipped with combination deflecting and needle-regulating nozzles, which are controlled by type Q Lombard governors. The switchboard consists of seven panels, and is fitted with the usual apparatus, and, in addition, there is an electrical attachment enabling the switchboard attendant to control the water-wheel governors. To indicate the height of the water in the penstock, current from the low-tension circuit is passed through an induction coil, thence to an ammeter. The height of the water determines the position of the height of the coil, and hence the ammeter readings The transformers, of which there are seven, each rated at 625 kilowatts, raise the voltage from 2,200 to 60,000, 50,000, 40,000 or 30,000. These are of the oil-insulated water-cooled type, and an automatic device discharges the oil outside of the building in case of a fire in the station. The lightning arresters are of the Siemens diverging-horn type, with choking coils on the station side. The high-tension switches are of a fused type, and consist of two diverging copper rods, similar to the lightning arresters, and which form the terminals of the leads. The circuit is completed by means of two knife-edge clips mounted on glass and coupled together by means of the fuse. This is operated by a long wooden staff. The transmission line is double, and is of No. 1 B. & S. gauge, seven-strand bare aluminum wire, set on poles 180 feet apart. The cross-arms are four and three-quarters and five and three-quarters inches by seven feet. The wires are arranged with six-foot centres, one on the pole top and two on each cross-arm. To protect the pins from leakage, each is covered with a sheet of zinc. The top of the pole is bound with iron wire, to prevent being split by the pin.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), February.*

The Chesapeake & Potomac Telephone System Restored.

When the recent fire at Baltimore destroyed the system of the Chesapeake & Potomac Telephone Company, it was announced that immediate steps were being taken to permanently restore the main exchange, which was entirely destroyed. As our readers will probably remember, it so happened that on the Saturday evening preceding the fire two new central offices had been opened. On the Sunday night following, when the conflagration was at its height, it was decided to enlarge one of the new offices which had been equipped to serve about 4,000 telephones, so as to serve over 12,000. Parts of a new board then in Washington, ready for installation in that city, were immediately shipped to Baltimore, and the necessary cables ordered from Chicago. Within two weeks the equipment for 4,000 telephones was in place, and the telephones were rapidly connected. The entire installation was completed on February 29, twenty-one days after the fire originated.

The new switchboard is 135 feet in length and contains 160,000 jacks. In constructing the board, 500,000 hand-soldered connections were made. Thirty-five miles of switchboard cable, containing 2,000 miles of wire, were used.

One week after the fire it was decided by the company's officers to retain the South exchange to serve subscribers in that part of the city below Pratt street. The work of altering the building to accommodate a larger equipment than had formerly been used there, and of installing apparatus to serve 4,000 subscribers, was pushed rapidly. An emergency board was shipped from Chicago for this purpose, and the installation was completed February 29, and put in service on March 2.

The loss of the telephone company was not confined to the property actually destroyed, as its cables and lines in the burned district were rendered useless for the time being. New cables have been made, however, and drawn into the subways and spliced. This work was interfered with to a considerable extent by the wrecking gangs who were engaged in tearing down walls in the vicinity of the manholes where the splicers were compelled to work. The final work of cross-connecting, testing and clearing out is well under way, and it is expected that this will be finished by the end of this week.

In carrying out its plans made at the beginning of the year, the company had just contracted for the erection of a three-story building, thirty-two by eighty feet, for telephone use exclusively, to be located at Wolff and West Fayette streets. This, when completed, will serve east Baltimore, and, meanwhile, subscribers in that part of the city will be connected to the Mount Vernon exchange. As all of the St. Paul telephone numbers have necessarily been changed, a new telephone directory has been prepared. This is now in press, and will soon be in the hands of the subscribers. None of the work done in the restoration of the system is of a temporary character.

Examination for Assistant Electrical Engineers.

The United States Civil Service Commission, Washington, D. C., announces that on April 6 and 7, 1904, there will be held an examination at various places throughout the United States to secure eligibles from which to make certification to fill vacancies in the position of assistant electrical engineers in the United States Signal Service at large, and other similar vacancies as they may occur; compensation to be $1,400 per annum. A list of the places where examinations will be held may be had by applying to the commission, at Washington, D. C. Applicants should have a good general knowledge of electrical science, and should be thoroughly familiar with telephone, telegraph and cable engineering.

The Preservative Properties of Creosote.

The excellent preservative property of creosote is demonstrated by the test which has been carried out on the French Eastern Railway, between Paris and Strasburg. In the years 1873 to 1876 ties which had been treated with this material were laid, each being marked with a nail bearing the date of laying. Last July a census was taken, and it was found that thirty-eight of these ties were still in service after a period of thirty years. On another piece of track between Paris and Mulhouse, 12,000 creosoted beech ties were laid in 1891. Twelve years after it was found that only twenty-four of these ties had been removed.

The Effect of the Russo-Japanese War on Copper.

An English contemporary states, that as Japan is an important copper-producing country, the war now in progress may have some effect on the price of this metal, many of the miners being called away for military service.

FIFTH GENERAL MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY.

THURSDAY, FRIDAY AND SATURDAY, APRIL 7, 8 AND 9, 1904.

The fifth general meeting of the American Electrochemical Society will be held at Washington, D. C., April 7, 8 and 9, 1904.

The meeting will be held at the Columbian University, corner Fifteenth and H streets, N. W.

Thursday and Friday afternoons will be devoted to visits to scientific laboratories, government institutions and various points of interest in and about Washington. On Thursday evening the presidential address will be delivered and will be followed by a complimentary smoker. Friday evening there will be a subscription banquet at the Shoreham, corner Fifteenth and H streets, N. W.

The following titles of papers have been announced:

"The Composition and Resolution of Voltages," by Dr. J. W. Richards; "Notes on the Industrial Electrolysis of Water," by Mr. W. S. Landis; "Standard Cells," by Dr. F. A. Wolff; "Electric Smelting Experiments for the Manufacture of Ferronickel from Pyrrhotite," by Mr. Ernst A. Sjostedt; "A Contribution to the Study of the Electric Arc," by Dr. Wm. S. Weedon; "The Energy of Ions," by Dr. L. A. Parsons; "Some Experiences in Copper Precipitation," by Hermann Poole; "A New Electrolytic Separation of Gold and Silver," by Hermann Poole; "The Preparation of Materials for Clark and Weston Standard Cell," by Dr. H. S. Carhart and Dr. G. A. Hulett; "The Determination of 'H,' at Annisquam, Mass., by Tangent Galvanometer," by Barry MacNutt; "The Economic Balance in Electrolytic Copper Refining," by Lawrence Addicks; "Single Potentials of the Halogen Elements," by W. R. Mott; "Observations on the Preparation of Electrolytic White Lead," by C. F. Carrier, Jr., A. C.; "Electrolytic Iron," by C. F. Burgess and Carl Hambuechen; "A Relative Decimal Index for Electrochemical Interests," by Adolph L. Voege. A paper by Mr. G. Westman, title to be announced.

Other papers are expected. A complete programme will be issued later.

The attention of members is called to the A. B. Frenzel prize of $250, the conditions of which are stated on page 10, volume iii, of the Transactions.

Those desiring advance sheets of their papers for distribution before the meeting should sent manuscript to the secretary at once.

The hotel headquarters will be at the Shoreham, opposite the Columbian University, corner Fifteenth and H streets, N. W.

The chairman of the local committee is Colonel Samuel Reber, and the secretary Mr. C. P. Townsend.

ELECTRICAL MINING NOTES.

BY SIDNEY F. WALKER.

REPORT OF HOME OFFICE COMMITTEE ON THE USE OF ELECTRICITY IN COAL MINES.

(Concluded.)

CLASSIFICATION OF PRESSURES.

The committee has adopted the British Board of Trade classification as to pressure. Services up to 250 volts are called low, services between 250 and 650 volts are called medium, services from 650 to 3,000 are called high, and from 3,000 upward are extra high. Only medium pressures are allowed to be taken beyond the main airways. There is a little ambiguity here. The main intake airway is naturally fed with fresh air from the surface, and is therefore free from gas, even in the most gassy mine, except under special conditions, but the main return airway should have all the gas which it has absorbed from the working faces. Probably the main intake is what is meant.

TESTING.

Periodical testing of all cables is enjoined, and the results of all tests are to be entered in a book kept for the purpose. Some arrangement is also to be made for testing the "earth," and the test is to be continuous, and to be recorded, as the insulation tests are. It is an open question whether it is wise to have a permanent connection to "earth" on the system, even for testing purposes. It means that you have a permanent possibility of trouble. Most engineers who are familiar with mining prefer an apparatus that is arranged to test when a switch is turned, or something equivalent. On the other hand, it is always possible that the electrician, or whoever the duty may devolve upon, may forget to make the test at the time he should, and so fail to receive the warning in due time.

THE USE OF HIGH PRESSURES.

The committee contemplates the use of high pressures, but only for transmission purposes. It was laid down forcibly by several witnesses that with the increased distances and the increased work to be done in modern coal mines it would be absolutely necessary to use high pressures. I have mentioned the case in previous notes, which came up in my own practice, where it made a difference of £7,000 in the cost of cables alone between using 2,000 volts and 500 volts. Although extra high pressures are mentioned, it is hardly likely that they will be used, for some time to come at any rate, except for transmission from large generating stations to different collieries in a district. In South Wales, for instance, where the idea of power generating stations has taken root, pressures of 5,000 volts and upward will be used for the overhead lines, radiating from the generating stations.

BARE CONDUCTORS.

Bare conductors are only to be used for overhead lines on the surface, and very careful rules are laid down for the construction of overhead lines. On no account are bare cables to be used in shafts.

USEFUL SUGGESTIONS IN CONNECTION WITH CABLES.

Many very useful and practical suggestions are made in connection with the fixing of cables in different positions, with the view of increasing the safety of the whole system. Thus with the trailing cables which are used to connect coal-cutting machines with the nearest junction box, it is recommended that in all cases the cables shall be attached to the machine first and to the junction box last. Also in shot firing, it is recommended that the connection to the explodes shall always be made last. These two rules, small as they are, appear to me to be particularly good, and such as are particularly of the kind that are wanted in coal mines. The great danger in connection with the use of electricity in coal mines, as in many other cases, is the fact that men are fiddling with cable connections and so on while the current is on. At the face of the coal, the conditions are particularly awkward. The junction box is necessarily some little distance back, and the temptation is to make connection as the attendant passes on to the face, and to chance getting shocks in making connection to the machine itself. The same thing applies to shot firing. The tendency is to connect the wires leading to the detonators to the magneto, and then to go on and connect them to the shots, so that if anything happens to the magneto, if some one gives it a turn, or where a galvanic battery is used if connection is made accidentally, the shot goes off, and a man is killed. The simple rule suggested will obviate all that. And that it is necessary will be evident from the fact that there have been several cases of premature firing of shots by electricity.

The firing of shots from the lighting service is not so much as mentioned. Apparently the plan has died a natural death, though at one time it was greatly favored by mine managers. Mr. Frank Brain, who is manager of the Trafalgar colliery, where electricity in coal mines may be said to have had its first trial, and who is, or was, also the managing director of a company which makes fuses for shot firing, had a patent, in the early days of electric lighting, for firing shots from the lighting service. Another colliery manager, who is now dead, who took a great interest in electricity, and I believe fitted up his own colliery, Mr. James Thomas, of Ynishir colliery, Rhondda Fach Valley, in South Wales, was very enthusiastic about firing shots from the lighting service, using the coal itself as the return. At that time also there was a strong feeling among mining managers, especially in South Wales, in favor of working the signals by currents taken from the lighting service. The rules applying to signaling are very short, merely to the effect that all connection with other conductors is to be prevented and that pushes and circuit-closers are to be so fixed that accidental signals may be avoided.

REGULATIONS FOR FUSES, SWITCHES, ETC.

The rules provide that only properly constructed switches and fuses are to be used. In the case of switches, they are not to heat when the full current is on, and they are not to arc, in switching off. Fuses are to be so proportioned that they do not heat with the full current, but interrupt the circuit when a short-circuit occurs, and when the current passing exceeds the working current by 100 per cent. Fuses are not to be placed in wall sockets, ceiling roses, or switch covers. Their covers must be of incombustible material, and either non-conducting or of rigid metal lined with insulating incombustible material, and be kept clear of internal mechanism. I think that hardly enough is made of the point that incombustible material should be used for switch bases, and covers, as far as it is possible, to have incombustible material.

COAL-CUTTING.

As will have been expected, the report and the rules give considerable attention to coal-cutting machines. They are to be in charge of men who are practical pit men, who are to be provided with safety lamps and are to test for gas frequently. Whenever gas is found, the machine is to be stopped and the current switched off at the nearest gate end-box until the gas has been got rid of. Frequent examination is to be made of the trailing cables, and if any wear or abrasion occurs the machine is to be stopped and the current switched off until it is repaired. The trailing cable is to be so arranged that no strain can come on the cable as the ma-

chine moves forward. Terminals are to be enclosed in flame-proof casing, and the motor casing is to be flame-tight, and sufficiently strong to resist a fall of roof or an explosion inside itself.

POSITIONS OF ELECTRICAL MACHINERY.

The committee lays it down very strongly that machinery which is worked by electricity underground shall be fixed in dry, well-lighted and well-ventilated places, as far as possible; and the machinery itself is not to be worked so that the rise of temperature will damage the insulation. The provision of well-lighted, dry, well-ventilated engine rooms is another wise provision. They have not always been the rule in the past. The electric motor has too often been pushed in anywhere where room could be found for it.

TELEPHONIC COMMUNICATION.

Telephonic communication is recommended between the generating station, the pit bottom and the distributing centres. This again is a very wise provision. Modern coal mines are very extensive, and often very deep, and it will save almost incalculable time if easy and quick communication is always practicable between some point near the face and the generating station.

H. M. INSPECTORS.

H. M. inspectors are made the ruling powers in connection with the establishment of electricity in any coal mine. Notice is to be given to the inspectors before an installation is put in, and they are rendered judges of existing installations. Plans are to be kept at each colliery where electricity is used, showing the position of every wire, cable, machine, etc. There should be no difficulty whatever about this. Every colliery is bound by law to keep a plan of the workings, which must be kept up to within a certain time, and the inspectors usually ask for the plan whenever they come to the colliery. Draughtsmen at collieries are usually very neat and clear in their work, so that they will easily be able to show the cables on a plan, a tracing of the principal plan, devoted to the purpose. It goes without saying what a boon this will be to the electrican in charge.

Temperature of Osmium Lamps.

A method of determining temperatures, suggested by Mr. H. F. Weber at the congress in Frankfort in 1891, has been used for ascertaining the temperature of the filament of the osmium lamp by Professor M. Lombardi. His results are abstracted in the London *Electrician* for February 12, and they show that, under normal conditions, the temperature of the osmium lamp is about 135 degrees centigrade less than that of the incandescent lamp, although the latter is less efficient as a luminous radiator than the former.

MINOR WIRELESS TELEGRAPH PROGRESS FOR THE YEAR 1903.

BY JOSEPH B. BAKER.

INTRODUCTORY.

In a former article[1] the results attained last year by the most eminent workers, and in the more immediately important problems of the art of space telegraphy, were set forth. In the present article it is the writer's purpose to complete the record for the year by mention of work upon problems that do not rank in present importance with such matters as successful tuning or persistent wave-trains, for example, but that yet have had the attention of experimenters who have patented or otherwise published their work. The term "minor progress," then, is made use of here to designate work whose importance of bearing upon the future commercial practice of space telegraphy does not as yet rank with the matters treated in the former article above referred to, whatever that future may bring forth. Yet much of such work is highly important in promise, and nothing is to be mentioned in the present article that does not have the right to be called an element in the development of this art. Thus, a broad division between essential advances and inventions that do not seem to form integral parts of the evolution of Hertzian-wave telegraphy must be made; and such matters as new complexities (electrical or mechanical) in transmitting or receiving stations, synchronized signaling methods and apparatus, non-Hertzian or pseudo-Hertzian organizations, organizations for distinct signaling, for switching between apparatus and the aerial or its equivalent, and various forms of adjustable detecting devices, usually of the coherer type, must, consistently, be omitted altogether. Such descriptions (added to several of a less worthy sort whose perusal with understanding of the trend of wireless development produces the impression of a hasty filing of padded, unoriginal or meaningless matter at the Patent Office) remind one of the swarm of applications of low average value that followed the inventions of Graham Bell in the history of the art of telephony.

BRANLY-POPP.

Early in the year the formation of a wireless telegraphy news-distributing company was reported, to utilize recent improvements of Professor Branly. The improved "Branly Tripod Coherer," a group of rather heavy steel legs with lightly oxidized points, resting on a polished steel plate and decohered by the slight shocks of the receiving instrument in operation, was stated to be an improvement in sensitiveness over the best forms of "filings tube" that had been originated by the academic experiments of Professor Branly described by him in 1891. A feature of this coherer—whose operation interestingly parallels that of the Hughes microphone—is that the lever of the receiving instrument, in descending to give a signal, is made to open the battery circuit to the coherer just before administering the mechanical shock which effects the decohering. The writer's immediate attention has been directed to various modifications of the tripod "coherer" during the past year, covering a certain range of experiment with this device; and there is some reason to believe that its best operating conditions are those that make of it a closed-circuit wave detector operated by the electrical energy dissipated in it, rather than an open-circuit "coherer" operated by the potential energy of the oscillations.

"DIRECTIVE POWER."

By this term may be meant the propagation of signaling waves in a predetermined direction rather than equally on all sides as from a simple antenna, or their propagation with greater intensity in the predetermined direction. Dispositions of radiating apparatus to attain such a result, sometimes in combination with an arrangement of antenna or associated apparatus at the receiving station whereby foreign or interfering signals or disturbances are suppressed in favor of signaling waves coming from the complementary station, have been designed from time to time; and the year 1903 witnessed a not inconsiderable interest in, and amount of work upon, such schemes to attain what may be termed "topographical selectivity." The prototype of all such attempts at directive power in Hertzian-wave signaling was the series of experiments with large parabolic reflectors performed by Marconi at the beginning of his work in wireless telegraphy; this work resting upon the academic work of Righi, and of Hertz himself.

In the article in the ELECTRICAL REVIEW for January 9, Braun's method of obtaining a "beam" of electric radiation was described. Among other schemes due to be briefly described under the title of the present article, Blochmann has a patent for a method that may be called heliography with invisible light (waves of the order of twenty centimetres in length), based upon the early exhaustive

[1] ELECTRICAL REVIEW, January 9.

academic work of Righi, and of Professor Bose of Calcutta, and employing materials of the highest obtainable refractive indices in lenses for directing a beam of radiation. The difficulties to be overcome in such a scheme—met with as well in the use of reflectors for the same purpose, as shown in some recent personal experiments of the writer's—are connected with the necessity of using very short waves in order to keep the physical dimensions of the directing apparatus at the sending station and of the intensifying apparatus at the receiving station down to practicable limits. The limitation in wave-length introduces the need of research on the difficulty of radiating any considerable amount of ether-wave energy from an oscillator of small physical dimensions; and especially of research on detectors that shall be sensitive, when connected to resonators (receiving antennæ and circuits) of small physical dimensions, to the signaling disturbances of such extraordinarily high frequency.

H. W. Ladd has a receiving antenna on board ship provided with a co-axial, rotatable conducting "shield" having a slot or opening; the object being to locate the angular bearing of a signaling station, at, say, a lighthouse on shore, by turning the shield till the receiving apparatus responds, by exposure of the antenna to waves reaching it through the "slot;" which manœvure thus gives (by observing the orientation of the slot) the nautical bearing of the signaling station. A consideration of this scheme points clearly to the essential use of short waves; alike to avoid diffraction troubles (at the edges of the slot) that would impair accuracy of "directive power," and to keep the walls of a shield of a practicable diameter at least $\frac{1}{4}$ λ from the antenna. Other recent patents worthy of note, in this department were granted to S. G. Brown and R. B. Owens. In a German periodical Brown and von Sigsfeld describe arrangements of wires auxiliary to the main antenna; and Stone, in several patent reissues from 1902, covers similar ground. Experiments of Professor Artom at Spellia, in which two transmitting antennæ gave a dirigible "field," are also reported.

It may be affirmed in regard to the whole subject of directive power for whatever purpose of "topographical selectivity," that it has a future and is capable of very great development beyond the point where Marconi's early work with very large reflectors left off.

Very early in the present year Dr. De Forest patented an organization for directed signaling, by Hertzian-waves, which it may be permissible to mention under the present heading, and which makes use of a modified Lecher wire, as an auxiliary to the antenna, placed horizontally in the plane of the emitting antenna and receiving station. The patents are of interest in comparison with the use of two vertical antennæ, located one-half wave-length apart, simultaneously operative upon a common detecting device, whereby directive selectivity is to be attained by the orientation of the plane of the antennæ, in an organization previously patented by Stone. It is interesting also to note that both the double antennæ systems of Stone and De Forest bear at least a superficial resemblance to the early suggestion made by Professor Elihu Thomson involving two vertical wires placed one-half wave length apart, the description of which is to be found in an interesting letter in the *Electrical World and Engineer* for June 3, 1899.

DETAIL DEVICES, DETECTORS, ETC.

The work of the year on receiving devices has included not only the refinement of apparatus previously made known, but also the invention of several new devices of promise. Now that selectivity by the electrical tuning of apparatus has been brought well within sight of commercial realization, the development of "detectors" toward efficiency and their reduction to reliable operativeness from the initial stages of uncertainty in working and "trappiness" of construction has become of the first importance. Unfortunately for purposes of general publication, the improvements that have been made in the older devices—such as the coherer itself in its various forms, for example—have been jealously guarded from public knowledge. A partial exception to this practice is found in the records for the year in the case of the Fleming form of magnetic hysteresis detector, based on Rutherford's observation that the passage of a minute oscillatory current in a helix surrounding a bundle of iron wires that was subjected to a periodically varying magnetomotive force caused a sharp modification of the hysteresis of the iron, ordinarily following a cycle under the influence of the magnetomotive force; and that this effect—which may be expressed as a sudden magnetization or demagnetization of the iron upon the passage of an oscillatory current due to the infringing of a Hertzian wave-train upon an antenna to which the apparatus was connected—might be observed by a galvanometer, or a telephone, connected to an associated coil in which the sudden change of magnetization induced a momentary current. In early apparatus making use of this phenomenon to receive space-telegraph signals, the cycle of magnetomotive forces was applied to the iron "core" of the detector by means of a rotating magnet kept in motion by a clockwork, and the dots and dashes were received as short and long scratching sounds in a telephone receiver connected as described. The improvement published by Professor Fleming early in the year consisted of a "core" of fine iron wires, which was magnetically excited by the periodic application, through a rotating commutator, of a battery current made to traverse a special winding upon the core; the commutator being provided with additional segments and contact brushes for applying the receiving instrument (galvanometer or telephone) as well as the antenna and the magnetizing current, to the detector in the proper order for most efficient operation in each cycle.

E. F. Huth published another form of magnetic hysteresis detector, in which the demagnetization effect is made to give direct deflections by a mirror secured to the "core," the latter being suspended by a filament, after the manner of a reflecting galvanometer. A. Plecher has patented a detector based on the principle of the capillary electrometer: minute variations in the height of a liquid column, under the action of feeble arriving disturbances, being magnified by optical means. Alexander Popoff has a patent on the self-decohering coherer, and the combination of the same with an induction coil. It is to be noted that the date of filing of this patent is March 8, 1900 (antedating the publication of the Castelli coherer), and that in spite of such an early filing date the claims are very limited ones. Dr. MacFarlan Moore substitutes one of his vacuum circuit-breakers, and described some years ago in connection with his "vacuum-tube" lighting for the spark-gap itself, in a patent for "electric control of devices at a distance." Anders Bull has published details of experiments with a synchronized wireless telegraph system embodying apparatus that allows for considerable error in synchronism; the claim being thus for a sort of mechanically attained secrecy.

The Cooper Hewitt Interrupter was announced during the year as a substitute for the air spark-gap, making use of peculiar conducting properties of mercury vapor, and was somewhat prematurely heralded as having an immediately important application in space telegraphy by

producing a genuinely continuous train of half-oscillations. Similar suggestions were made by Simon and Reich. It is likely that in due time publication will be made of progress with such devices, but at this date we are not justified in expecting much improvement in wireless by their use; but would expect more value to the art from Fessenden's compressed-air spark-gap described in 1902, or from Braun's spark-gaps in series. This latter scheme, patented recently, uses several spark-gaps in series each shunted by a condenser, whereby the total charging potential on the aerial is considerably increased for a given length of sparks compared to what it would be for the some aggregate discharge distance in a single spark. Moreover, the total aggregate resistance of the sparks is less than in the corresponding single spark. The phenomenon utilized by Fessenden might have been predicted from the perusal of existing work by Professor J. J. Thomson on the passage of electricity through gases, whereas we must attribute Braun's work to an actual discovery. The well-known reduction efficiency of a "spark-coil" when required to deliver its spark in the compressed gaseous atmosphere of an explosion-engine—whereby its spark is greatly shortened compared to its length in air—is worthy of note in this connection.

There has been no progress worthy of note, during the year, over work previously announced, expressed in patents or other publications, upon true Hertzian-wave telephony. The wide-spread interest in this subject, however, warrants a brief mention of the work of Ruhmer with his clever utilization of the old selenium cell photophone receiver of Graham Bell in combination with the "speaking arc" (originated by H. V. Hayes and developed abroad by Simon and Duddell) and requiring careful research in the improvement of each element of the apparatus. The large amount of quantitative experimental work, on the solenium cell alone, performed by Ruhmer and required to produce an apparatus that is reported to have carried articulate speech a distance of five kilometres in the summer of 1902, illustrates well the necessity, not always realized by the supporters of an inventive enterprise, of taking time for complete, unhurried solution of detail problems.

Such achievements, brilliant and of probable future value as they are, do not, however, constitute any advancement of the art of "wireless telephony" in the meaning of that term as generally understood. The utilization of variations, constituting a copy of articulate speech, in a beam of exceedingly short electro-magnetic waves (light) whereby such audible signaling is accomplished in a definite direction but with obvious limitation of distance, is not the kind of wireless telephony that we figure to ourselves as such when thinking of transmission of speech by Hertzian radiation. There have been some extravagant claims for systems of non-Hertzian telephony without connecting wires; and such schemes have been confused, in the minds of many, with the notion, not justified by experiments of any prominence, of a method of speech transmission by the use of a spark-gap and aerial similar to those employed in space telegraphy whereby telephone exchanges, wires, and cables, were to be done away with.

Among the non-Hertzian schemes of telephony there is a certain amount of experimentation going on with the old method, dating back to Lindsay, on which Sir William Preece has done the best-known and most practical work: the utilization of the spread of lines of current flow in the earth or water, between the grounded ends of a wire carrying the signaling current and strung generally normal to the direction in which signaling is to be effected, whereby signals are received upon apparatus, (for telegraphing), preferably adjusted to mechanical resonance with the frequency of signaling currents used and connected in a second wire generally parallel to the first and having its ends grounded. Such systems have had rare and special commercial application because of the great length of wire required to be strung for a given "reaching power" normal to the wire, and have been less penetrative for commercial telephone transmission than for telegraphy. Some experiments of Armstrong and Orling have been referred to in the English attempts to materially shorten the "base lines" for a given signalling distance.

Electrical Exposition at Warsaw.

An electrical exposition will be held at Warsaw, Russia, from May 1 to August 1, 1904. Articles for exhibition will be admitted free of duty, and it is expected that this exposition will afford an opportunity of bringing a great many products before an entirely new class of purchasers.

During the seven months ending with January, there was an increase in exports of manufactured copper; the export figures for the seven months ending January, 1904, being reported as $31,552,677, as against $22,514,843 for the corresponding months of last year.

THE CONDUCTIVITY OF THE ATMOSPHERE AT HIGH VOLTAGE.

(Concluded.)

BY HARRIS J. RYAN.

Figs. 3, 4, 5 and 6 are half-tone reproductions of diagrams of line-wire and capacity-rod charging currents, photographed from the screen of the indicator. Eight of these were observed in this series at maximum voltage wave values varying from 23,000 to 48,000 volts. To give a clear idea of the characteristics of these diagrams it is necessary to reproduce only the above four.

In Figs. 3′, 4′, 5′ and 6′ the waves indicated in Figs. 3, 4, 5 and 6 are drawn to scale in rectangular coordinates. They show at once the nature of the phenomena of atmospheric conduction giving rise to a loss between wires at high alternating voltages.

The waves of line and condenser charging currents are identical in Figs. 3 and 3′, which were observed at a voltage having a maximum value of 23,000. The voltage was not yet high enough to cause the atmosphere about the line wire to break and become conductive. The charging current applied from the wire to the cylinder was identical with the true capacity charging current from the rod to the cylinder.

When the voltage was slightly raised, a well-defined though small change in the line-charging current appeared as a hump on either side of its indicator diagram (see Fig. 4), or a sudden increase in the current, just as it was about to pass through zero, as seen in the rectangular coordinate diagram of this same wave shown in Fig. 4′.

At exactly the same value of voltage at which this hump in the line current appeared the corona became visible when viewed in the dark, thus settling definitely this point and providing a convenient and reliable guide in subsequent experimental studies.

It should be observed that the manner of departure from normal capacity form of the line-charging current is much as one would expect from prior knowledge. After the phenomenon has been started, at that instant in each cycle when the voltage attains a value of 20,000, the atmosphere about the line wire breaks and forms a conducting envelope about wire.

As the value of the voltage is very near the maximum it follows that the disrupting dielectric strain can last but a brief portion of a cycle. Beyond this the normal true capacity condition will be assumed in which the rod and wire-charg-

ing currents are again in agreement. The atmospheric conducting action in this instance, then, is to increase the capacity of the wire by covering it with a high-resistance conducting envelope during that portion of a cycle in which the instantaneous voltage is high enough to maintain in the atmosphere next to the line conductor a state of strain sufficient to maintain disruption.

Thus it is seen that the electric circuit from the wire to the cylinder changes during the cycle from a state of true and unvarying capacity to one of increased and variable capacity in series with a high resistance.

FIG. 3.—LINE AND CONDENSER CHARGING CURRENT.

These two actions evidently contribute to the same result; *viz.*, the establishment of a component of current passing from wire to cylinder that is in phase with the voltage and which, therefore, dissipates energy in heat at a corresponding rate.

We did not succeed in starting the hump in the line-current wave at a lower voltage than that applied for Figs. 3 or 3′. By raising and lowering the voltage and watching the indicator it was evident that it required a slightly higher instantaneous voltage to start the conduction than that required to maintain it. It is highly probable that the high temperature reached by the conducting envelope, due to heat produced by the current, will account fully for this.

As the voltage is raised the departure of the line-charging current from its normal true capacity form occurs to a remarkable degree. The maximum value of the voltage-wave was set at 26,500 volts and the card of Fig. 5 was obtained from which the waves of Fig. 5′ were determined. Qualitatively, there are here observed precisely the same phenomena as in Figs. 4 or 4′. The atmosphere remains conductive during a large part of the cycle, returning to the normal with corresponding coincidence between the condenser and line currents during the remaining small portion of the cycle. It may be noted that whereas 20,000 instantaneous volts were required to maintain a minimum corona in the condition that produced Figs. 5 and 5′, the definitely lower value of 17,000 volts is required, due again probably to the higher temperature of the ruptured atmosphere.

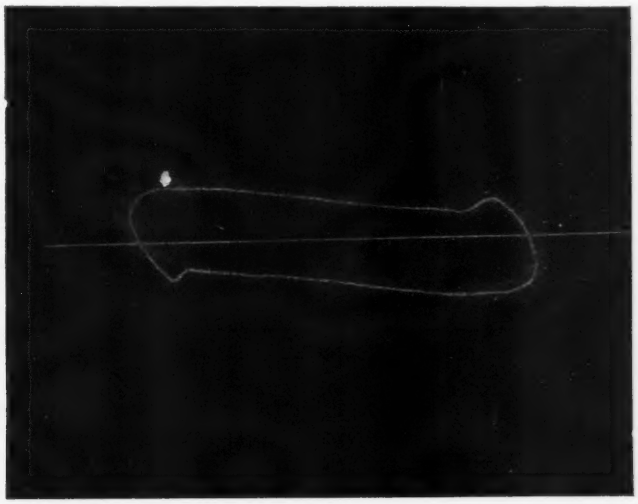


FIG. 4.—SHOWING SMALL CHANGE IN CHARGING CURRENT.

When the voltage wave was raised to the maximum value of 48,000 volts, the cards and corresponding waves in Figs. 6 and 6′ were obtained, while the disruption evidently occurs at 17,000 volts as before. So important a part is now taken by the resistance and fluctuating capacity that there is no longer a continuation at

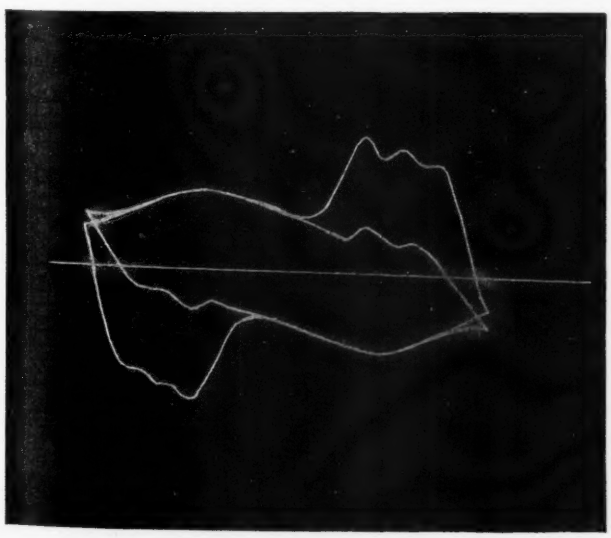


FIG. 5.—HIGH-VOLTAGE WAVES.

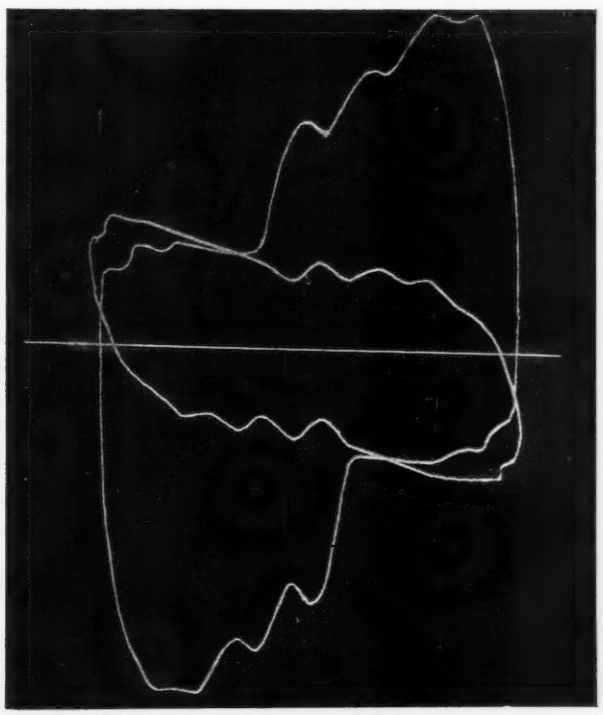


FIG. 6.—MAXIMUM VALUE OF 48,000 VOLTS.

any point throughout the cycle of coincidence between the capacity rod and line-wire charging currents.

These voltage waves were determined by integrating the capacity-rod charging currents. Their scale was obtained by observing the maximum values by means of a spark-gap. The wave-indicator scale

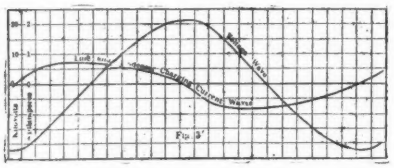


FIG. 3'.—LINE AND CONDENSER CHARGING CURRENT.

for the currents in the case of each card was easily obtained from the effective value of the sine-wave current read from an ammeter connected in circuit with the coil C''.

In all, eight of these cards were taken and worked up in the foregoing manner. Products of the current and voltage-waves were made and averaged by integration so as to obtain the watts lost in corona display over the wire at each corresponding alternating voltage applied. These results were charted in Fig. 7, locating the curve there drawn.

The way was now clear to determine experimentally the validity of the expression derived above, provided there was some method for determining the distance from the surface of the conductor at which the initial break occurs. I am indebted to Mr. B. T. McCormick, a senior student in my classes last year, for a method by means of which this may be accomplished. Assisted by Mr. C. L. Gillespie he applied it to many of the commercial sizes of conductors ranging in diameter from 2 to 625 mils. At the centre of the fifteen-inch cylinder conductors of various diameters were mounted. An alternating voltage was applied between the conductor and the cylinder and elevated to the point at which corona is first visible in the dark. The diameter of the conductors and the maximum value of the voltage-waves were observed by means of the spark-gap. Corresponding to each conductor and the maximum value of the voltage at which its corona was initially formed, curves were located showing the relation between the dielectric flux-density and radial distance from the surface of the conductor. These curves were then plotted in rectangular co-ordinates in the same manner as shown in Fig. 8. The envelope of these curves when taken at sufficiently small intervals of conductor sizes, gives the relation between the distance from the surface of the conductor and the dielectric flux-density at which the atmosphere first ruptured. In this manner the relation between the conductor diameter, distance from surface and dielectric flux rupturing density, was determined. The values thus determined are given in the synopsis; *i. e.*, in the tables in the earlier chapter.

One especially interesting feature of the results given in this table is that the

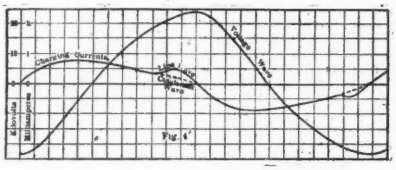


FIG. 4'.—SLIGHT CHANGE IN CHARGING CURRENT WAVES.

distance from the surface of the conductor at which the atmosphere first ruptures is constant at 0.07 inch for all diameters above 0.25 inch and the corresponding rupturing flux value is constant at 170 x 10^{-10} coulombs per square inch. The largest conductor used in these experiments was 0.625 inch in diameter. It is, however, reasonable to expect that since there is no change in the value of d due to changes in the conductor-curvature when the diameter varies from 0.25 to 0.625 inch, there will be no important change in such value of d for conductors

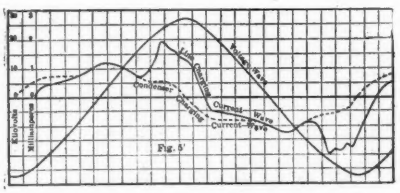


FIG. 5'.—HIGH-VOLTAGE WAVES.

of larger diameter. At conductor diameters smaller than 0.25 inch, there is approximately a regular diminution with the diameter of the distance of the initial rupturing-zone and a corresponding approximately regular rise in the initial rupturing dielectric flux-density.

To study the effects due to varying barometric pressures and temperatures, a conductor 0.125 inch in diameter was mounted at the centre of a stout brass cylinder twenty inches long and 8.75 inches in diameter, provided with packing flanges and closed with 0.5 inch plate-glass at either end. By means of ordinary hand-pumps and a long mercury U-tube, the atmospheric pressure could be adjusted definitely to any desired value from eighteen to thirty-six inches of mercury. Alternating voltage was applied between the conductor and the cylinder and elevated to the point where the corona was observed in the dark to appear suddenly. The effective values of the voltage were determined by means of a Weston alternating-current voltmeter applied across the terminals of the low-voltage primary of the high-voltage transformer. Throughout all experiments the form of the voltage-waves was approximately the same; *viz.*, that given in Figs. 3', 4', 5' and 6'; frequency 130 cycles.

With the atmosphere in the cylinder at the room temperature of seventy degrees Fahrenheit, the observations showing the relation between corona starting-voltage and atmospheric pressure were made that are found charted in Fig. 9. They locate a right-line relation, the equation of which is

$$K_v = 0.902\, b + 2.93 \qquad (11)$$

wherein

K_v = effective kilovolts required to start the corona.

b = barometric pressure in inches of mercury.

To determine the effect of variation of temperature upon the voltage required to inaugurate the corona, the air in the tube was heated electrically and cooled by immersion in a salted ice-pack. However, the salted ice method for cooling was not a success and had to be abandoned, it being evident that a much more extensive method of cooling would have to be used in order to maintain the surfaces of the glass plates closing the tube free of moisture, so as to ensure effective insulation

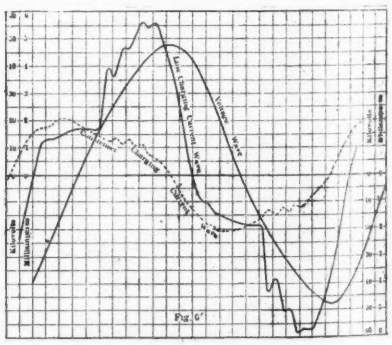


FIG. 6'.—MAXIMUM VALUE OF 48,000 VOLTS.

and clear vision for the detection of the corona. The cooling facilities that are evidently needed were not at hand when these tests were made, last May, so we had to be contented with such temperature variation of the air as could be obtained by heating the tube electrically by means of a jacket of German-silver wire and

asbestos. Observations were made to determine the combined effects of temperature and barometric pressure variation by heating the air in the tube to about 200 degrees Fahrenheit, at a given barometric pressure, then as the temperature dropped slowly by radiation and by maintaining the barometric pressure constant by use of the pump or by natural flow of the atmosphere, the voltage at the various temperatures required to start the corona was observed. The process was then repeated for another barometric pressure until finally observations had been made covering the temperature range of from seventy degrees Fahrenheit, to near 200 degrees Fahrenheit, at barometric pressures ranging from nineteen to thirty-four inches. The humidity present was that

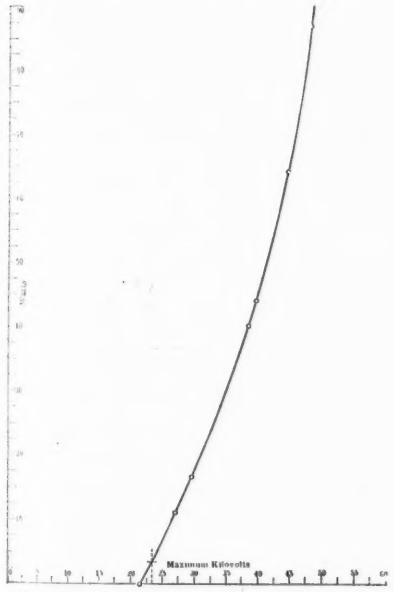


FIG. 7.—PRODUCTS OF THE CURRENT AND VOLTAGE WAVE.

due to natural causes and was not observed.

A target-diagram of these observations, including those made at seventy degrees Fahrenheit, is shown in Fig. 10. The observations made at room temperature are much more reliable than those made at other temperatures. The reason for this is the uncertainty of the actual temperature of the atmosphere in contact with the conductor at the centre of the tube when at a different temperature from that of the outside atmosphere. The difference in temperature causes a transfer of heat from one side to the other that occurs largely by means of convection currents that give rise to the uncertainty of the temperature at the centre of the tube. However, the observations made at the constant barometric pressure of 29, 26.5 and 19 inches of mercury left no doubt of the nature of the barometer temperature-voltage variation as shown by the lines thus located in Fig. 10 and which indicate a close agreement between the

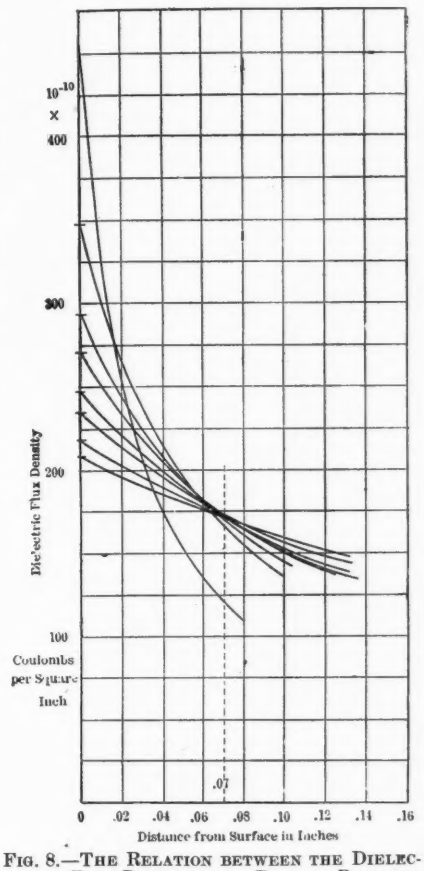


FIG. 8.—THE RELATION BETWEEN THE DIELECTRIC FLUX-DENSITY AND RADIAL DISTANCE FROM SURFACE OF CONDUCTOR.

variation of the corona-forming voltages and the atmospheric density.

The fact that there is an addition-constant in the equation for the barometric pressure-kilowatt line for seventy degrees Fahrenheit, in equation (9), shows that the barometric pressure-temperature-corona-forming voltage relation of Fig. 10 will not be accurately expressed in a for-

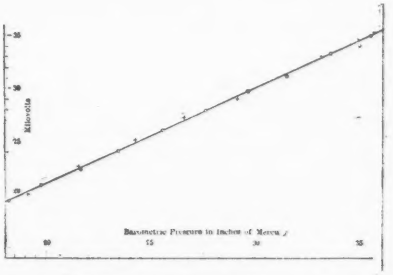


FIG. 9.—RELATION BETWEEN CORONA-STARTING VOLTAGE AND BAROMETRIC PRESSURE.

mula which assumes that the corona-forming voltage varies exactly as the density of the atmosphere. However upon trial it was found that the assumption that it does so vary will provide an expression giving the results charted in Fig. 10 with sufficient accuracy for practical purposes.

The corresponding correction-factor to

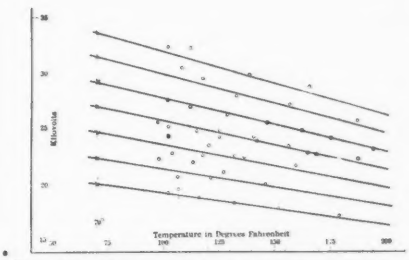


FIG. 10.—TARGET DIAGRAM OF TEMPERATURE OBSERVATIONS.

be applied to equation (9), to account for barometric pressure effects different from 29.5 inches of mercury and temperatures different from seventy degrees is

$$\frac{17.94\ b}{459+t}$$

wherein

b is the barometric pressure in inches, and

t the temperature in degrees on the Fahrenheit scale.

The final equation which allows for all important factors showing the relation between the instantaneous maximum voltage, size and separation of conductors, rupturing value of dielectric flux, and distance from the surface of the conductor at which the rupture occurs, causing initial corona formation should, therefore, be written

$$E_{max} = \frac{17.94\ b}{459 \times t} \times 2055 \log_{10} \left(\frac{s}{r}\right) D' (r+d) \times 10^{-10} \qquad (12)$$

A determined effort was made to observe

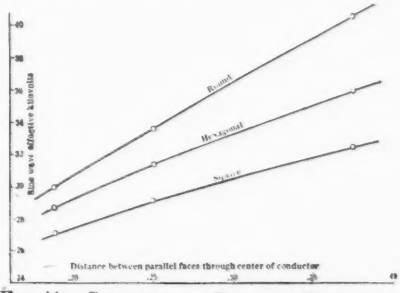


FIG. 11.—COMPARATIVE DATA ON DIFFERENT FORMS OF CONDUCTORS.

the effect upon the point of initial corona formation due to the presence of moisture in the atmosphere. The ordinary air in the tube was displaced with dry air and the corona-starting voltage was then observed. Steam was then admitted to the interior of the cylinder and after allowing sufficient time for the water that was not absorbed by the air to settle upon the

walls of the cylinder, the corona voltage was again observed. By this method the effect of the presence of humidity could not with certainty be detected, leading one to conclude that such effect if it does exist is small.

Where the conductors are 0.25 inch or larger in diameter, D′ and d remain uniform at

$D' = 170 \times 10^{-10}$ coulombs per square inch, and

$d = 0.07$ inch

and equation No. (12) becomes

$$E_{max} = \frac{17.94\ b}{459+t} \times 350\ 000 \log_{10} \left(\frac{s}{r}\right) (r+0.07) \qquad (13)$$

The data for Mershon's experimental line are

s = 15, 22, 35, and 52 inches.

r = 0.081 inch.

$D' = 200 \times 10^{-10}$ coulombs per square inch.

d = 0.035, inch.

t = about 60° Fahrenheit.

b = about 20 inches.

1.71 = approximate ratio of maximum to effective value of voltage-wave.

Upon substituting these values in equation (12), the following results are obtained:

Separation of Lines.	Effective Voltage at which Initial Corona Loss Occurs.	Mershon's Observations. Effective Voltage.
Inches.		
15	43,600	43,500
22	47,800	47,000
35	50,700	49,000
52	54,000	53,500

In this table the values labeled "Mershon's Observations" were taken at the point of intersection of the voltage base-line in Fig. 1 formed by the broken-line extension of the vertical portion of the loss curves. Mershon's conclusion is that the small loss portion, *i. e.*, the horizontal portion of these loss curves, is due to the line insulators, while the large increase of loss beyond the sharp rise in the curve is due only to the atmospheric loss. The laboratory tests confirms this fully. Some will insist that if this is strictly so the sudden rise in the loss curve should make an abrupt and not a gradual turn upward. Upon further thought it must be evident, however, that as the voltage is raised atmospheric conduction will first appear over the sections of the wire in contact with the insulators which have a higher specific inductive capacity, *i. e.*, a higher permeability to dielectric flux than the atmosphere, causing the electrostatic field about the wire in the neighborhood of the insulators to be higher than in a position remote therefrom. On this account the initial start of the atmospheric conduction loss will not appear abruptly when the

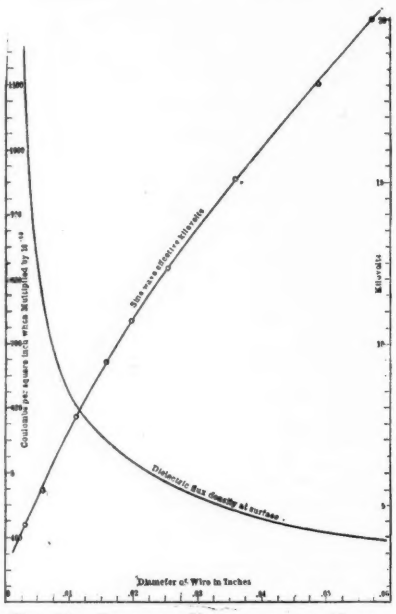


FIG. 12.—ORIGINAL EXPERIMENTAL DATA

voltage is increased gradually through the corona-forming value. It is to be noted that the vertical portions of these loss curves as extended to the base of the diagram, form curves having substantially the same character as the corresponding laboratory loss curve given in Fig. 7. It is from this point of view that the above

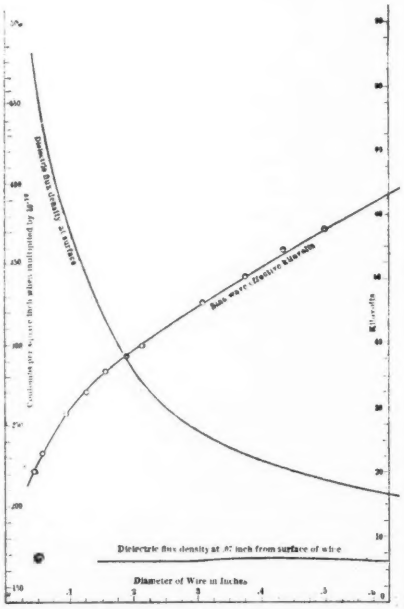


FIG. 13.—ORIGINAL EXPERIMENTAL DATA.

method was employed for locating the value of the voltages that started the corona losses on the Telluride line.

Professor Harold B. Smith has erected an experimental high-voltage line at Worcester Polytechnic Institute, 250 feet long, upon which conductors have been mounted varying in size from No. 10 to No. 2 B. & S. gauge and high-voltage losses have been measured, due to electromotive forces ranging from low value to upward of 250,000 volts. He has very kindly given me three of his voltage-line loss curves taken from these lines, arranged as follows:

Length of lines, 250 feet. Observed May 14, 1901; May 3 and 28, 1902. Barometric pressure, 29.5 inches; temperature, seventy degrees Fahrenheit.

Curve No. 1—Size of wire, No. 10 B. & S. G. Separation thirty inches, voltage-line losses measured over a range from 30,000 to 100,000 volts.

Curve No. 2—Size of wire, No. 2 B. & S. G. Separation twenty-four inches, voltage-line losses measured over a range from 30,000 to 145,000 volts.

Curve No. 3—Size of wire, No. 2 B. & S. G., separation forty-eight inches voltage-line losses observed over a range from 30,000 to 150,000 volts.

For a No. 10 B. & S. G. wire:

$d = 0.018$ inch.

$r = 0.05095$ inch.

$D' = 275 \times 10^{-10}$.

No. 2 B. & S. G. wire:

$d = 0.07$ inch.

$r = 0.1288$ inch.

$D' = 170 \times 10^{-10}$.

Substituting numerical value in equation (13) for the two No. 2 lines and in (12) for the No. 10 lines, the following results are obtained for comparison with the measurements by Smith:

Smith's voltage-measurements were made with a special and highly satisfactory form of electrometer. Strict agreement of the calculated and effective results can not, however, be expected without a knowledge of the ratio of the maximum to the effective values of the actual high-voltage waves impressed upon the line. The last column in the above table gives these corresponding maximum effective ratios that would bring the calculated and experimental results into exact agreement. The ratios indicate the use of a somewhat peaked line voltage-wave which is apt to be the case owing to the distortion produced in the high-pressure transformer by the delivery of the line-charging current.

Naturally the conductor having a circular exterior section is the one best adapted, other things being equal, for the avoidance of atmospheric loss. The ordinary stranded cable exposes nearly a circular sectional area, so that in respect to the avoidance of this sort of loss the cable

should give substantially the same results as the solid conductor. Evidently when the voltage is such as to demand a greater exterior diameter of conductor than that corresponding to the solid section required for the economical or efficient transmission of the current, the solid or stranded conductor can be made hollow or provided with a non-conducting core. A few observations were made by using round, hexagonal and square conductors at the centre of a fifteen-inch cylinder for the purpose of obtaining comparative data, applicable to the corona-forming voltage as affected by those forms of sections. These observations are charted in Fig. 11, from which it is seen that while the exterior surface and total section of the hexagonal conductors are greater than for the same thickness of round conductor, yet the corona losses are started at lower voltages. The same is true naturally to a greater extent for the square conductor.

Line.	E_{max}.	Efficiency.	Efficiency.	E_{max} Efficiency.
	Maximum instantaneous voltage at which corona loss occurs, determined by equations (12) or (13).	Reduced from E_{max} by the factor $\sqrt{2} = 1.415$	Observed by Smith. (Located by intercept upon voltage axis of voltage-watt curve as was done in connection with Mershon's curves. Fig. 11.)	As a factor in lieu of $\sqrt{2}$ required to bring calculated and observed results into exact agreement.
No. 10 B. & S. G 30 in. separation	107,700	76,000	66,000	1.63
No. 2 B. & S. G. 24 in. separation.	158,000	112,000	100,000	1.58
No. 2 B. & S. G. 48 in separation.	178,500	126,000	100,100	1.61

The cause of this is obviously due to the concentration of the dielectric flux at the surface angles of the non-circular sectioned rods.

The curves in Fig. 12 and 13 were determined from observations made in the thesis work of Ford and Wernicke, and McCormick and Gillespie. They are reproduced here because they constitute original data that are useful for analogous purposes other than those to which they were applied in this paper. The curves labeled "sine-wave effective kilovolts" give the relation between the voltages and diameters of conductors mounted at the centre of the fifteen-inch cylinder at which initial corona occurred for a diameter range of 3 to 600 mils. The remaining curves give the corresponding calculated dielectric flux-densities at the conductor surfaces. The voltages were determined by a spark-gap discharger having a scale laid off in terms of sine-wave effective volts.

A SUBSTITUTE FOR THE SPARK-GAP METHOD FOR GAUGING THE MAXIMUM VALUES OF HIGH VOLTAGES.

The maximums of the highest alternating voltage-waves may be gauged easily when applied between wires of suitable diameter, the separation of which is adjusted until the initial corona appears in the dark. From the conductor diameter and separation, barometric pressure and temperature, a determination of the maximum of the voltage-wave may easily be made that will be just as accurate as the constants in the equation (10), or the location of the curves in Figs. 12 and 13, or made with such increased accuracy as will be obtained in similar determinations in the future. This method is free from the fluctuating indications and objections that attend the use of the spark-gap, while its only real objections is that the observations must be made in a place that is moderately dark.

In conclusion, attention is called to the fact that no experiments were made to determine the effects that the presence of rain and snow in the atmosphere have upon the point of initial corona formation. It appears from Mershon's Teluride results that there will be little effect from this cause.

With regard to the effect of the presence of smoke it should be said that there is evidence that a very slight loss is produced at all voltages, which is greater at the higher values due to this cause. During the spring of 1903, on days when the atmosphere was very smoky on account of neighboring forest fires, Dr. Blaker observed in the physical laboratory at Cornell that the conductive discharge through the atmosphere was appreciable when a continuous voltage of 15,000 was applied between wires of such size and separation that no detectable conduction occurred when the atmosphere cleared.

Those who have made line observations and who may use them to check the results given in this paper, must not fail to eliminate, first, the effects due to the presence of the supporting insulators.

It is altogether unlikely that changes in frequency, even over wide ranges, will affect appreciably the voltage at which atmospheric conduction is started when all other conditions remain the same.

THE PROMOTION OF BUSINESS.

BY ARTHUR WARREN, IN THE "NEW YORK TIMES."

It all came about—my part of it, I mean—through a cable message to London inviting me to return to New York and confer there with the man himself on a matter of business. That was in 1897. I had then made a score of journeys across the Atlantic as a newspaper man. Since then I have doubled the number. But the twenty-first journey was to meet the great manufacturer in New York on a Saturday morning. The Lucania made the interview possible. The appointment was for 10 o'clock. At 10.10 I had left journalism and was drawing salary from my new chief.

"Meet me at the works next week," said he, "and take up details there."

But there were no details to take up. They did not exist. My work had to be created. Before it could be created I had to learn what all this ado was about.

The first day in that grim western city was unforgetable. It was a day with a master mind. "Come with me," said the Chief, "and keep your eyes and ears open." We went through his various establishments, huge places where the newest methods of manufacture were in force, where applied science was yoked to the wheels that made money. There were brainy men as well as brawny ones at every turn. New inventions were shown to me. They were in the experimental stages.

"Here is the coming thing," said the Chief. "Its importance can hardly be overstated. When we are ready, I'll give you the word to push this with publicity."

Six years passed before the word was given—so long, so careful were the tests, the calculations, the changes.

"Meanwhile, here is another new thing. It is ready. Push it."

We walked through the place. He saw everything in flashes, asked a hundred questions, inspected tests and drawings, gave instructions, criticised, gave men new ideas. Then we crossed the street and entered another manufactory, a vast place, and now three times as large. It employed 3,000 hands then; there are 10,000 now.

"I am going to build here, and here, and here," said he. "People ask why? They say there will never be work enough to keep the present shops going at full capacity. But they don't understand the possibilities; they don't look ahead."

There you have the man; sanguine,

never satisfied, thinking faster and further than other men, sure of himself, indomitable. At that time this special manufactory sold $2,000,000 worth of product in a year. Now it sells $25,000,000 or $30,000,000 worth. And if the Chief is to enlarge these works again he must go some miles distant, for he has covered all the available land.

Summarized, the conditions, as I saw them, were these:

Half a dozen great manufacturing companies, each separately organized, with separate boards of directors and executive officers, each company engaged in a distinct branch of engineering, all the companies controlled by one man—the Chief; all working under one banner—the Chief's. The name of the Chief loomed so large before the minds of men that the outer world hardly knew one company from the other. People spoke of the Chief's "company" as if there were but one, and as if it made all things.

Publicity Point No. 1—Bring out the individuality of each company and the products thereof.

Point No. 2—Bring out the relationship of each company to the Chief, for the Chief's name was one to conjure by. The Chief was a great personality, a great power, therefore a great asset, from the point of publicity.

Point No. 3—The world believes in personalities, not in corporations. Therefore, when the world thinks of any of these varied lines of industry, make it think of the Chief. Make the name synonymous with achievement and the best workmanship, with reliability and daring and success.

Point No. 4—The great profits in manufacture are not necessarily in the great contracts that everybody talks about, but in the steady output of what you might think minor work—the standard products. Everybody knew that the Chief's companies did big things; they did not know that the companies did the little things, and wanted to do more of them. It was thought in the trade that these big organizations would not bother with small orders. Remedy that!

The undertaking seems simple enough, but it is not. Engineering can not be advertised like shoes and soaps. The daily press, the fashion papers, the billboards, the street cars, the painted signs along the railroads are not the publicity mediums for high-grade engineering.

There was a time when good wine needed no bush, when great industrial concerns scorned publicity. But competition has changed the conditions in the last half-dozen years. We led the way.

The way to business success was once defined for me by the late Philip D. Armour:

"First, know what you want to do; second, get the right men to do it."

In industrial lines business is appealed for through the technical press and the trade journals. The general public knows next to nothing of these publications, of their ability, their influence, and the extent of their business. But for the most part these papers are indispensable, their ability is of a high order, their influence considerable and well employed, and the aggregate extent of their business is very large.

Before long there were seventy publications on our lists. No two had the same advertisement, and the copy for all was changed for every issue. Mining papers do not wish what railway papers require, nor do buyers for shoe factories read the journals taken by steel mills.

A most effective branch of the work was our service of articles for the trade and technical press. It had always been a point of criticism on the part of technical and trade editors that they could not get timely and sufficient information from the companies of the Chief; usually they could not get it at all. The bureau of publicity changed all that. It supplied information, articles, photographs, and cuts from one end of the country to the other, describing the work that was going on, the machinery that was being erected in Washington Territory, Texas or Peru; the railway equipments that were being installed; the huge engines that were newly turning over their wheels in the great cities. This work was vastly useful. And the experts of the technical and trade press were invited to the works from time to time to meet our experts in engineering. And each learned something from the other.

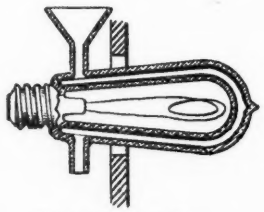
The bureau of publicity was at the same time a bureau of suppression. A good deal of matter that would have been "live news" we were not permitted to touch because competitors might be benefited. There were new technical practices that we must not talk about. Nevertheless, the editors were kept busy. You could not take up a technical or trade paper in the land without seeing that the Chief's companies were very much alive.

A journalistic training is of the first importance in this kind of work. The "nose for news" scents the interesting facts from afar, and experience in presenting facts is kept employed in letting the world know what is going on. The Chief's technical experts were encouraged to write, but they could not write much because their duties as experts were paramount. They were paid to be engineers, not publicists.

The bureau of publicity was managed as an editor manages a daily paper. The men attached to the thirty or forty sales offices throughout the country were our reporters and correspondents. At headquarters I had writers on the various branches of engineering; a photographer, a printer of photographs, an enlarger of photographs, a retoucher for half-tone work, two men to read proofs and "make up" publications; a designer of advertisements; thousands of half-tone cuts and electrotypes, so stored and indexed that any one could be found in an instant; 25,000 photographic negatives similarly arranged; a circulation department to distribute our output.

Electrical Patents.

A colored sign lamp has been invented by Mr. Walter Lytton, of Chicago, Ill. In this invention a suitable support is provided upon which the improved apparatus is mounted, the support being provided with an upper rearwardly projecting ledge or cap-piece which overhangs the apparatus and serves as a support for certain parts thereof. A series of lamps is mounted in the support and projects from the front side thereof, the base or socket end portions extending through the support and being exposed at the rear side of it. These lamps are incandescent electric lamps and each comprises an ordinary plug, with which is connected the usual filament, an inner enclosing bulb and an outer enclosing bulb. Between the bulbs is a surrounding chamber with the upper side of which communicates an inlet passage and with the lower side of which communicates an outlet passage. These passages are formed by means of integral tubular extensions or nipples, the former of which is provided with a

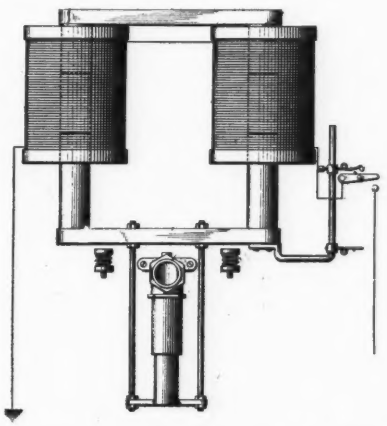


COLORED SIGN LAMP.

funnel-like mouth and both of which are located at the base end of the lamp in rear of the supporting board. A turn-cock is mounted below the lamps, the outer or casing member of which may be seated in or otherwise secured to the rear side of the support, so that the body of the turn-cock projects at right angles from it. The turn-cock is provided with a plurality of radially disposed inlet and outlet nipples, each adapted for connection with a communicating pipe. The turn-cock is also provided with intersecting transverse passages arranged to register with the inlet and outlet nipples above mentioned. Upon the outer end of the turn-cock is mounted a rigid radially extending arm to the outer end of which is connected the lower end of a T-shaped lever, pivoted at its upper end the length of its incross arms to a suitable pivot stud upon the back of the support. The communicating pipe connects with another pipe which in turn communicates with the lower side of each one of the lamps through the passages thereof. These pipes extend to

and respectively communicate with the lower sides of reservoirs, which are mounted so as to be raised and lowered relatively to the lamps, so as to produce an alternate inflow and outflow of the liquids contained by the respective reservoirs. The operation of the apparatus is as follows: the two reservoirs are filled with two differently colored fluids and are so arranged that the fluid from one reservoir will flow downwardly through the pipe, through the turn-cock and into the chambers of several lamps, thereby enclosing the inner bulb within a colored fluid and thus coloring the transmitted light accordingly. To change the color of the lamps, the operator will rotate the crank handle in the proper direction to lower one reservoir, thereby elevating the opposite reservoir, and inasmuch as the liquid within the lamps will begin to return to the reservoir as soon as it reaches a level lower than that of the lamps, if the lowering movement be not too rapid the liquid will all have returned to the reservoir by the time the latter reaches approximately its lower limit of movement. While one reservoir is being lowered, the other reservoir will be correspondingly elevated, but the T-lever will remain stationary and the position of the cock unchanged until the reservoir reaches and engages the arm, whereupon the cock will be shifted to a position to close one of the pipes and open the other pipe, it being noted that in its changed position the intersecting passage of the turn-cock will be placed in communication with one pipe and one end of the passage in communication with the other pipe. As soon as the parts have assumed their positions, the liquid from the reservoir will flow into lamps and thus change their color.

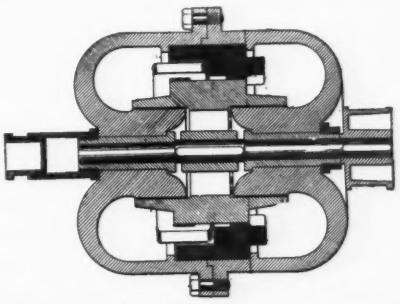
An electric pump for switching mechanisms has been invented by Walter J. Bell, of Los Angeles, Cal., who has assigned one-half interest to Leon F. Moss, of the same place. A pump cylinder is employed in which is slidably arranged a hollow piston, open at both ends and provided with a packing. The pump is immersed at its lower end in a body of liquid, preferably oil, the oil being admitted to the cylinder by the open lower end of the piston. At the upper end of the piston is an inlet check valve which is preferably in the form of a ball which seats by gravity on the upper end of the piston and is free to be raised therefrom to admit oil to the cylinder during the downstroke. A fluid-pressure-conducting pipe which leads to the switch tongue-operating piston is connected to the cylinder by an elbow. In the pipe is a check valve which may be of the usual construction. Fixed to the lower end of the piston are laterally extending arms, which connect with the yoke of a pair of solenoid-magnet armatures, the latter extending in elevated position within the magnets at a distance equal approximately



ELECTRIC PUMP FOR SWITCHING MECHANISM.

to two-thirds of the height of the magnets. A yoke connects the magnet cores, which latter extend into the magnets a distance about equal to one-third of the height of the magnets. Fixed to the yoke is a laterally projecting arm supporting at its outer end a vertical rod. Two spring arms are mounted on the rod through the medium of set collars, preferably intermediately coiled. In the path of one arm is a pin and another pin is located in the path of the other arm. Between the pins is pivoted a switch lever movable between stop-pins, and a contact is located in the path of the free end of the contact lever. A wire connects the contact with the feed wire, and the switch lever is connected at its pivotal point with one of the magnets by a wire. The magnet is connected with its companion magnet by a wire and the latter magnet is grounded through a wire. The downstroke of the piston by which oil is admitted to the cylinder is effected by gravity, and when near the end of the stroke the arm snaps from the pin against a pin or shoulder on the switch lever and drives the latter into engagement with the contact. Current is thereby caused to pass through the circuit. The downstroke of the piston is limited by spring stops, preferably located in the path of the yoke, and during the downstroke the valve is unseated. The magnets being energized the armatures are raised and the piston is elevated to force the oil contained in the cylinder through the medium of the seated valve through the pipe, the valve being unseated by the pressure. When near the end of the upstroke of the piston, the arm snaps from the pin against the shoulder on the switch lever and forces the latter from engagement with the contact, thereby breaking the circuit through the magnets. The circuit being broken, the piston moves downwardly by gravity until the circuit is again established.

Mr. Leon Jules Le Pontois, of New Rochelle, N. Y., has manufactured a method of producing sparks in the cylinders of internal combustion engines. Heretofore, two kinds of electric generators have been used for this purpose, namely, the continuous-current dynamo, self-exciting or excited by permanent magnets, and the alternating-current magneto constructed with a permanent magnetic field and a shuttle-wound armature. In order to do effective work, it is necessary that the magneto should run at such a speed in relation to the speed of the engine that the current generated reaches its maximum intensity when the circuit is opened by the circuit-breaker in the engine cylinder. The magneto must therefore either be driven at the same angular speed as the engine or by gears at a multiplied speed, so that the current will always reach its maximum when a spark is desired. In carrying out the in-



LONGITUDINAL SECTION VIEW OF A POLYPHASE MAGNETO-ALTERNATOR.

vention an electric generator is employed, delivering two or more alternating currents differing in phase from each other, with a multiple circuit-breaker so constructed that the different currents delivered by the generator may be broken simultaneously in the combustion chamber and so that the total heat energy of the spark or sparks resulting from the interruption of the different circuits is at any given time almost constant. It is obvious that as the currents are differing in phase one or more of them will reach sufficient intensity at the time of opening the circuit, and therefore the simultaneous opening of all the circuits will result in one or more sparks having sufficient heat value to explode the mixture in the chamber.

FANS FOR 1904—INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Electric Fans for Present Year.

THE electric fan for 1904 will not show any radical departure from what we are already familiar with, at least in general characteristics and appearance. Several makers have wisely eliminated a few intermediate sizes, but will present, this season, a sufficient variety of types and designs to meet any requirement. The field appears to be about evenly divided between the alternating and direct-current apparatus.

Within very recent times there has been worked up a prejudice against straight-blast fans, and this has created a demand for oscillating devices, designed to distribute the current of air over a wide range. These devices have taken on a number of forms, and include auxiliary mechanical attachments, oscillators forming an integral part of the fan construction, and still others which are simply provided with pivotal bearings and depend on air-reaction for their variable movement.

The ceiling and column fans with electrolier attachment are now seen in all large stores and restaurants and these will be shown in many handsome types, the possibility of ornamentation in this direction being considerable.

Of course each year brings the fan motor nearer to mechanical and electrical perfection. Bearings, oiling and economy of current consumption have all received severe attention by the manufacturers, as well as the proper proportioning of coils, insulators and commutating surfaces.

The following descriptions and illustrations give an idea of the variety and extent of the apparatus which prominent manufacturers have placed on the market for 1904:

GENERAL ELECTRIC COMPANY.

In this year's production the General Electric Company presents a convertible type motor. This marks a distinct departure in the design of fan motors, and the convertible feature will be found of great convenience both to dealers and to customers. The desk motors may be changed to bracket motors simply by the use of a small adapter, thus dealers may carry a supply of desk motors and a few adapters and can supply an order either desk or bracket motors. Customers will find these motors convenient because of the facility with which they may be converted from desk motors to bracket motors.

FIG. 1.—GENERAL ELECTRIC ALTERNATING-CURRENT FAN.

The general construction of the motors, as illustrated in Figs. 1, 2, 3, 4, 5, 6 and 7, is similar to last year's design. As shown in the illustration, the controlling switch for the alternating-current motor is now placed in the fan motor base. The simplicity which has marked the construction of the alternating-current motors for several years is retained in this year's models.

No moving wire or contacts are used and the revolving parts are carefully balanced on one long bearing. The direct-current motors have enclosed dust-proof frames, although the rectangular brushes and brush-holders are easily reached by means of a removable shield. In the convertible type this company offers twelve-inch and sixteen-inch motors for both direct and alternating-current circuits.

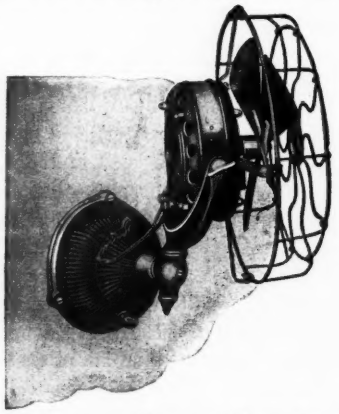


FIG. 2.—GENERAL ELECTRIC CONVERTIBLE, FOR ALTERNATING CURRENT.

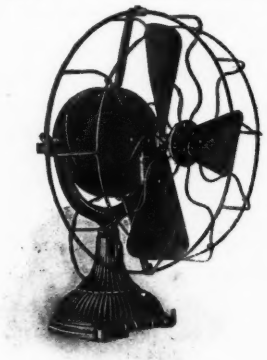


FIG. 3.—GENERAL ELECTRIC SWIVEL FAN, FOR DIRECT CURRENT.

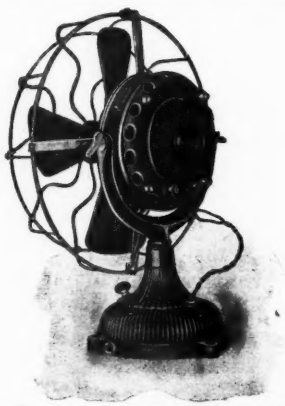


FIG. 4.—GENERAL ELECTRIC SWIVEL FAN FOR ALTERNATING CURRENT.

Besides the convertible type of motors, the General Electric Company is still supplying a swivel-frame twelve-inch motor for alternating currents, and a solid-frame twelve-inch motor for direct current.

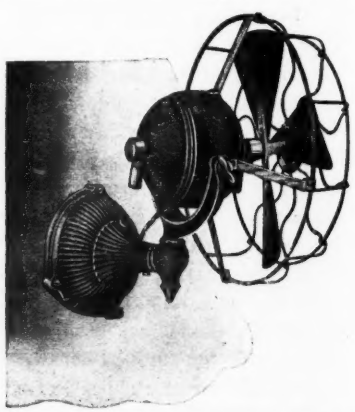


FIG. 5.—GENERAL ELECTRIC CONVERTIBLE FOR DIRECT CURRENT.

Particular attention is called to the substantial guard with two outer protection rings which are used on these motors. All these motors are fitted with variable speed switches, thus perfect control of the fan is provided.

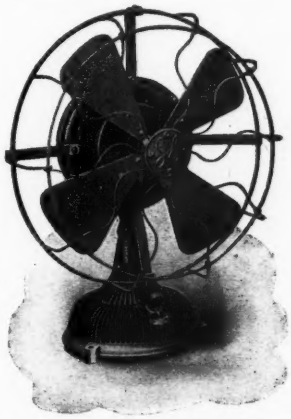


FIG. 6.—GENERAL ELECTRIC SOLID FRAME FAN FOR ALTERNATING CURRENT.

In addition to the standard products indicated, this company also manufactures direct-current ceiling fans, the so-called radial fan motors for desk use which throw a gentle breeze in a horizontal plane, and light bracket motors with spring suspension for places where a heavier wall bracket motor is not suitable.

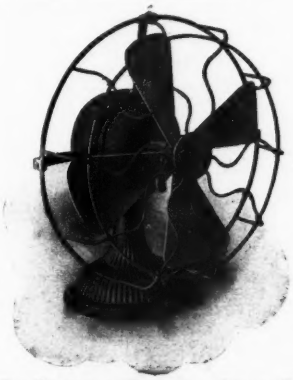


FIG. 7.—GENERAL ELECTRIC SOLID FRAME FAN FOR DIRECT CURRENT.

The standard finish for all of these motors is black enamel with polished brass fans and guard.

PEERLESS ELECTRIC COMPANY.

The Peerless Electric Company, Warren, Ohio, will not show any additions to its standard line of fans for 1904. Its fans will have much the same general appearance, and while every distinctive feature will be retained, every electrical and mechanical improvement that years of experience and progressiveness can suggest will be employed.

All of the desk and bracket fans made by this company are equipped with swivel and trunnion arrangements. The ceiling fan, with black japan finish, will be supplied this season with swivel and speed controller. The Peerless alternating-current desk and bracket fan will be offered with a number of improvements.

Fig. 8 shows the type "G" direct-current desk fan. The blades are of heavy spring brass, firmly riveted to a solid cast brass centre, with hub of ample length to ensure a firm bearing on the shaft.

The guard is made of heavy brass, of great strength and rigidity. The guard braces are of malleable iron, and are four in number.

The armature is built up of sheet-steel laminations, securely fastened to the shaft. The windings are thoroughly insulated from contact with all metal surfaces. The commutator is made up from sections cut from hard-drawn copper bar, the segments being insulated with high-grade India mica.

The lead wires are fastened into slots milled in the ends of the commutator segments, and are bound to an asbestos ring which prevents injury from rough handling or vibration.

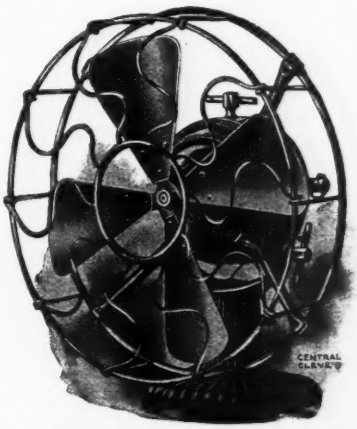


FIG. 8.—PEERLESS DIRECT-CURRENT DESK FAN.

Self-aligning and self-oiling bearings are made from high quality gun metal. Wick-feed oil cups of large proportions, holding sufficient oil to last an entire season, are provided, and all desk fans have an oil-catching device which prevents any leakage or spraying.

Carbon pencil brushes of large cross-section and extra length are used, and these are controlled by compression springs.

The field coils are protected by a heavy layer of insulating material, strongly taped. The coils are form-wound, with cotton or silk-covered wire, according to the voltage requirements.

The speed-regulating device is made up of German silver wire, wound on a porcelain spool. This gives the fan three speeds and a cutout.

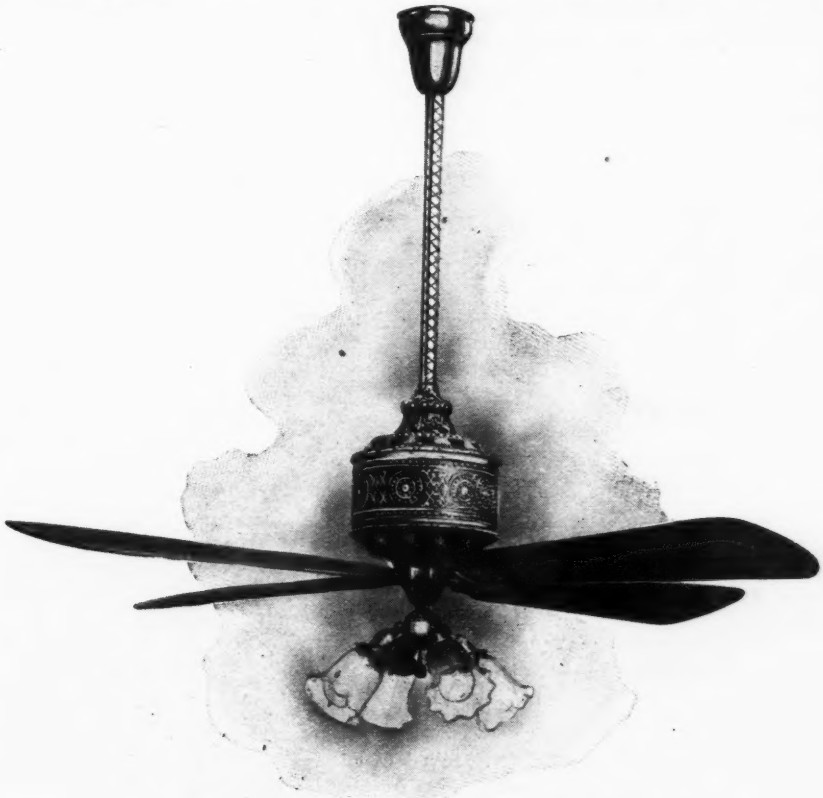


FIG. 9.—PEERLESS DIRECT-CURRENT CEILING FAN.

Fig. 9 shows the type "H" direct-current ceiling fan with a four-light electrolier attachment. The blades are of light, well seasoned wood, and are set at an angle of fifteen degrees. They have a

slight bevel from centre to edge, and the distance of the blade from tip to tip is sixty inches, the width of the blade at the end being eight and three-quarters inches, tapering in width to the shank. Gun metal self-oiling and self-aligning bearings are used, and the bearing is encased in a large receptacle holding about a half pint of oil.

The commutator is made of large section, and the lead wires are fastened into slots in the commutator segments, leaving the commutator straight across the face, without a shoulder for lead wires.

The brushes are a composition of carbon and graphite, making a self-lubricating brush of low resistance and large cross-section.

The brush-holder consists of a thin brass shell, held in an insulated sleeve. This is kept firmly in place by a clamp from the bottom of the hub.

The field coils are wrapped with specially prepared tape, and are subjected to a breakdown test of 4,000 volts. The armature is of the ironclad type, built up of specially prepared sheet-steel laminations.

B. F. STURTEVANT COMPANY.

Figs. 10, 11, 12 and 13 illustrate some of the types of electric fans built by the

FIG. 10.—STURTEVANT EIGHT-POLE MOTOR DRIVING STEEL-PLATE FAN.

B. F. Sturtevant Company, Boston, Mass.; these fans have different types of motors for different classes of service. Fig. 10 shows an eight-pole open machine direct-connected to a steel-plate fan. Fig. 11, an eight-pole open machine direct attached to a cast-iron or monogram type of fan. Fig. 12, an eight-pole semi-enclosed motor direct-connected to a fan of the propeller type. This motor can be made fully enclosed by the use of covers to close up the openings in the case. Fig. 13 illustrates the enclosed bipolar machine as used for driving fans of the propeller type. The field-magnet ring of the bipolar machine is of cast iron with detachable steel or wrought-iron field cores. The machines having steel field cores are provided with polar extensions cast integral with the magnet cores, and those having wrought-iron cores are provided with cast-iron shoes. The magnet or field coils in all cases are form-wound of

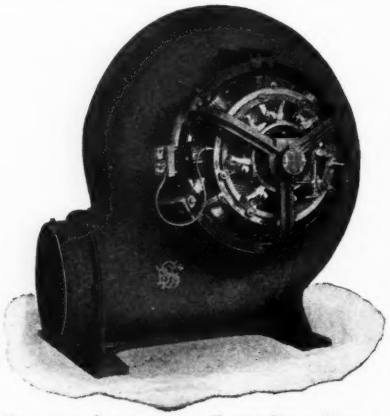


FIG. 11.—STURTEVANT EIGHT-POLE MOTOR DRIVING MONOGRAM FAN.

double cotton-covered magnet wire and are insulated in such a thorough manner that a grounded or broken-down field coil is a very unusual occurrence. The coils after being assembled upon the magnet cores are given a breakdown test of 1,500 volts, alternating, applied for one minute.

All the motor armatures are of the toothed-drum type, having form-wound armature coils insulated in the most thorough manner by the use of heavy cotton tape and fish-board and horn fibre. They are thoroughly saturated with a waterproof insulating compound and baked for a sufficient length of time to drive out all moisture.

On motors of three-eighths horse-power (driving a thirty inch propeller fan) and under, the brushes are round carbon pen-

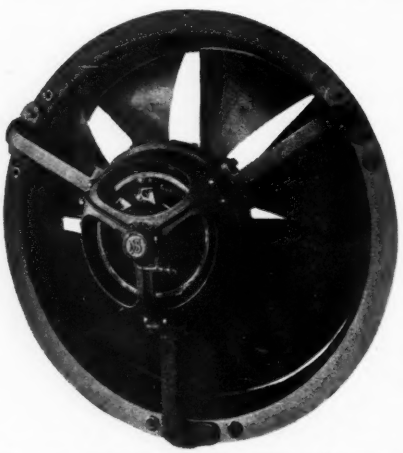


FIG. 12.—STURTEVANT OPEN-TYPE MOTOR DRIVING PROPELLER FAN.

cils fed in cartridge-type holders by helical springs. In larger machines ordinary rectangular carbon brushes are used, fed in holders of the sliding-socket shunt-type, the pressure being regulated by an adjustable flat phosphor-bronze spring. All motors are furnished with self-oiling, self-aligning boxes.

The commutators are constructed only of drawn or drop-forged copper bars insulated with the most carefully selected amber mica and thoroughly tested before being attached to the armature. The insulation between the segments and the shell is of micanite, no fibrous material of any kind being used in the construction of the commutator. These commutators are assembled under great pressure at a high temperature, thus assuring a commutator of solid construction, and one in which the mica between the segments is not liable to creep and produce sparking due to high mica.

All parts of the machine are made of the very best material in the most workmanlike manner, and before being shipped every machine is given a full-load run for a sufficient length of time to attain a maximum temperature, and every part critically examined before it leaves the testing department. Every means possi-

FIG. 13.—STURTEVANT ENCLOSED MOTOR DRIVING PROPELLER FAN.

ble is resorted to to ensure that nothing but strictly first-class machines leave the works.

THE KNAPP ELECTRIC AND NOVELTY COMPANY.

The Knapp Electric and Novelty Company, New York city, manufactures a low priced fan taking current from portable batteries. This fan is designed for use where street current is not available. The field is formed from steel punchings, and a drum-type armature is used. The brushes are readily adjusted while the motor is running, and automatic-feed oil cups are used. The motor is mounted on an iron base, fitted with a starting switch and rubber feet. The fan is finished in

black enamel with nickel-plated trimmings.

The fan throws a good breeze directly forward, or can be tilted to an angle either up or down, or made into a wall bracket fan by adjusting the wing nuts at the lower sides of the field.

This fan is usually run from a battery box containing twenty cells connected in four multiples of five in series each. The motor takes so small a fraction of an am-

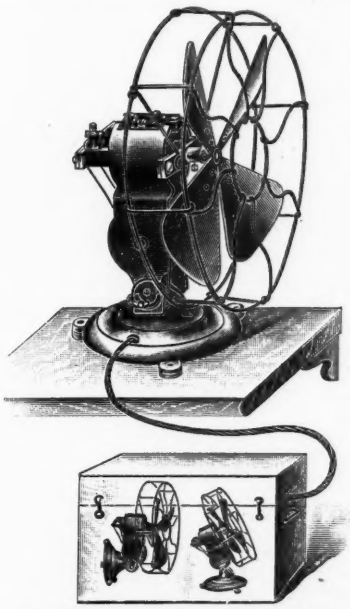


FIG. 14.—KNAPP ELECTRIC MANUFACTURING COMPANY BATTERY FAN.

pere each time as to enable the battery to stand up to the work for a considerable time. Running six hours per day, it gives about 200 hours' work. If worked continuously, not allowing the battery to recuperate, the life is consequently greatly reduced. Where constant work is necessary, as in the sick room, it will be more economical to alternate with extra sets of battery.

The battery box is wired complete, and is furnished with a diagram showing how to put in the cells and make the proper connections.

The motors are rated at approximately five volts and one-half ampere. The weight is five pounds free, seven and one-half pounds boxed.

AMERICAN BLOWER COMPANY.

The American Blower Company, Detroit, Mich., is the manufacturer of the well-known "A B C" disc ventilating fans. These fans are adapted for the ventilation of all types of buildings, the removal of smoke, fumes and gases, steam and dust, for the cooling of overheated apartments, for heating and drying in connection with heating apparatus, either with furnaces or steam coils. They also are employed economically to assist the draught in ventilating shafts or eduction flues in large public buildings.

A very popular disc ventilating fan is that shown in Fig. 15. This is equipped with a direct-connected electric motor. The motor frame is cast in one circular piece, without joints, and is made of fine cast steel of high magnetic permeability. The pole-pieces are of cast steel, provided with shoes to hold the field coils in place. The bearings are supported by brackets bolted to the frame, are self-oiling and self-aligning, made of bronze, carefully reamed and presenting a large surface.

The armature is of the iron-clad coil-wound self-contained type. The core is built of annealed sheet-steel laminations, mounted and keyed upon a shaft of large diameter. The armature coils are copper wire, form-wound, insulated and embedded in the slots punched in the arma-

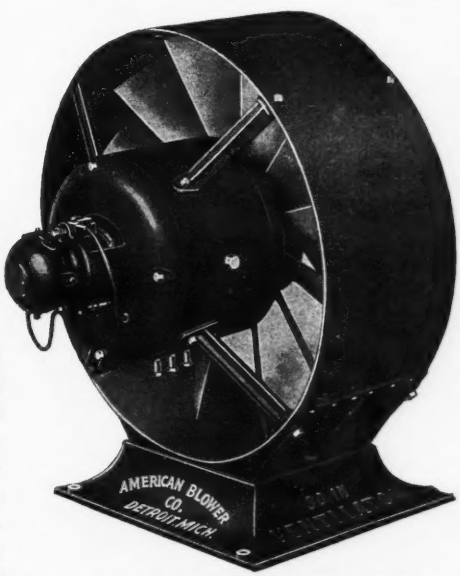


FIG. 15.—AMERICAN BLOWER COMPANY DIRECT DRIVEN DISC VENTILATING FAN.

ture discs. The coils are bound firmly in place between the teeth by band wires. The commutator is heavy and of large section. The field coils are machine-wound, and the brush-holders are of heavy brass construction, provided with adjusting screws for regulating the pressure of the brush on the commutator.

Speed regulation is accompanied by a rheostat, which is designed to reduce the speed approximately fifty per cent.

The base of the "A B C" fan is made of solid cast iron. The arms are cast iron, with a yoke in the centre to support the bearings. The ends of the arms are bolted to the fan casing and the case. The casing is of sheet steel, completely enclosing the fan blades. The shaft is of fine quality cold-rolled steel. The journals are self-oiling and self-aligning. The blades and central discs are made of steel, each blade overlapping the one next to it. Each blade is bolted to two large centre discs, one of which is on either side. The arrangement and proportioning of the blades prevent a back flow of air through the centre when working against pressure.

THE D. L. BATES & BROTHERS COMPANY.

The D. L. Bates & Brothers Company, Dayton, Ohio, manufacturer of fans and

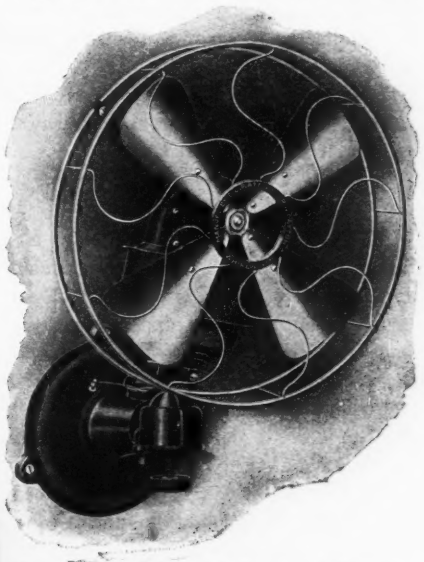


FIG. 16.—D. L. BATES & BROTHERS DIRECT-CURRENT BRACKET FAN.

electrical machinery, will offer the same line for 1904 as has been well known for some years.

Fig. 16 shows the bracket fan for direct

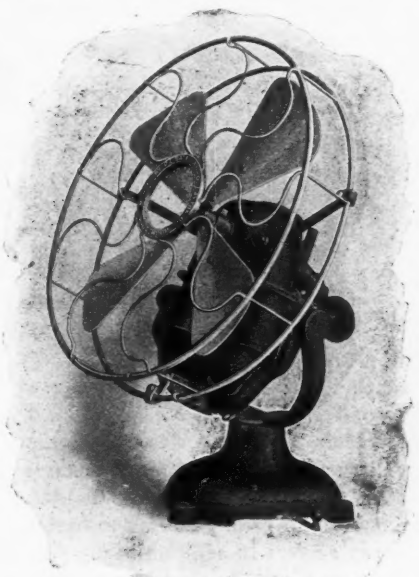


FIG. 17.—D. L. BATES & BROTHERS DIRECT-CURRENT TRUNNION DESK FAN.

current, and Fig. 17 the trunnion desk fan for direct current. In addition to these, the company manufactures a four-

blade ceiling fan for direct current, any voltage, a revolving electrolier ceiling fan, an electrolier column fan, a three-speed switch fan for direct current, and a two-blade ceiling fan.

In these fans the field coils are six in number, and are form-wound on two hard fibre spools. They are slipped over the poles and wedged into position. The bearings run continually in self-oiling boxes, requiring oil but once a season. The lower bearing is self-aligning by the weight of the armature, and the bearings are interchangeable and can be renewed at any time.

The brushes are of a special grade of carbon, in rectangular form, and contact is regulated by a spiral spring.

SPRAGUE ELECTRIC COMPANY.

The Sprague Electric Company, New York city, manufacturer of the "Lundell" fans, maintains the high quality of construction and graceful appearance which have made its product so popular in past years. These fans will be made for 1904 in various types and sizes which are sufficient to meet all requirements of the trade.

Fig. 18 shows the twelve-inch fan motor for 115 and 230 volts. This is made in both desk and bracket styles, and is equipped with a starting and regulating switch giving three speeds—900, 1,250 and 1,650 revolutions per minute.

Fig. 19 shows the sixteen-inch fan motor, for 115 and 230 volts. A starting and regulating switch gives this fan three speeds—800, 1,150 and 1,550 revolutions per minute. The bracket fans are so ar-

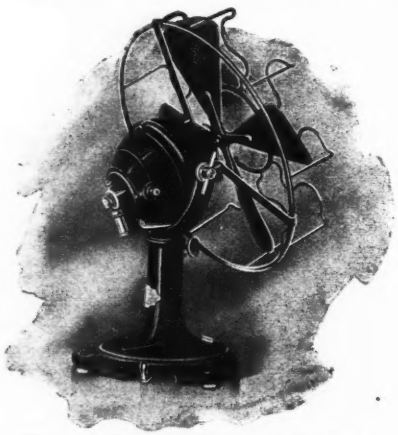


FIG. 18.—SPRAGUE ELECTRIC COMPANY TRUNNION DESK FAN.

ranged as to permit the fan to be turned at any angle. In addition to these styles, the company will present a twelve and sixteen-inch swivel and trunnion desk fan, small exhaust fans, and parts complete.

The "Lundell" fan motor is of the single field coil type, in which a single coil energizes both pole-pieces. The motor has a strong torque, permitting the use of fan blades of considerable pitch, so that they will drive a large volume of air at a given speed with a small amount of current. The actual current taken by a twelve-inch fan motor, running at its highest speed and displacing the maximum amount of air, is stated to be 0.43 ampere on 115 volts.

Self-oiling and self-aligning bearings are used, and these are equipped with self-feeding oil cups.

A rheostat is concealed in the base of the motor stand. The coil is divided into circuits, giving three distinct and varying speeds. The brush-holders are simple and compact. The carbons can be removed, turned or replaced with little trouble. The pressure spring and all the parts are of ample carrying capacity.

The armature is built of accurately cut discs of thin soft iron, having suitable

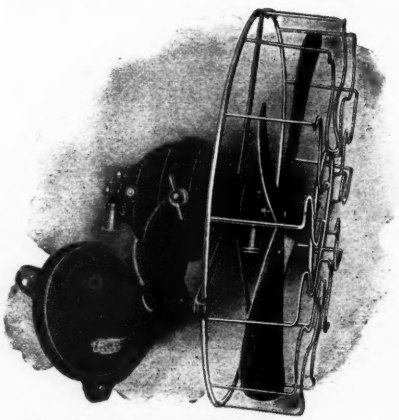


FIG 19. SPRAGUE ELECTRIC COMPANY TRUNNION BRACKET FAN.

teeth cut in the periphery for the reception and protection of the coils. These discs are securely keyed on to the shaft, compacted under pressure, and locked with retaining nuts.

The fan blades are firmly riveted to a spider, and a large set screw and deep slot in the shaft retain the spider in position.

THE SHEDD ELECTRIC AND MANUFACTURING COMPANY.

The "Comfort" oscillating electric fan, with oscillating base, is manufactured by the Shedd Electric and Manufacturing Company, of 50 Leonard street, New York city. The construction of this fan is well shown in the accompanying illustration. The motor is of bipolar type. The field casting is exceptionally heavy, and is cast in one piece. The field coils are machine-formed, wound and saturated with insulating compound. The armature is of the tunnel drum type, and the discs are punched with the key which fits into the key-way on the shaft, rendering them rigid and impossible to turn. The commutator is insulated with mica between the segments, and is of large proportions. There is sufficient metal so that, if desired, it can be turned off a number of times. The armature is silk-wound and thoroughly insulated. A graphite brush is used, supported by a tubular brush-holder with screw cap.

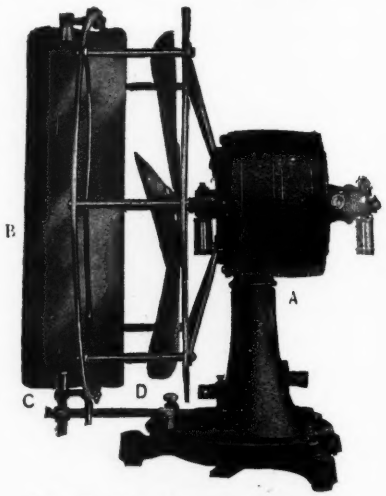


FIG. 20.—SHEDD ELECTRIC COMPANY "COMFORT" OSCILLATING FAN.

The bearings are self-aligning, and under-type wick-feed oil cup is used.

All parts of the motor are interchangeable, being made by a most improved and accurate system of jigs. The current is transmitted from the base to the motor proper by a system of collector rings and brushes, eliminating shunt cords or similar appliances.

The fan has two speeds—1,400 and 1,800 revolutions per minute for the twelve-inch, and 1,200 and 1,500 revolutions for the sixteen-inch size. Notwithstanding the fact that, owing to the auxiliaries, the fan does more work, it consumes no more current than the ordinary rigid type fan. The actual current consumption of the twelve-inch size is about forty-three watts, and for the sixteen-inch size, about ninety watts.

A novel feature of this fan is the rheostat, which is composed of a composition block about one-half inch square and two and one-quarter inches long. This is mounted flat on the porcelain base, and is practically indestructible.

The fans are made for the standard voltages—110, 220 and 250, direct current, but a fan for any special voltage may be made to order.

The guard is made of solid brass, highly polished. All parts are held rigid by screws, no solder being used anywhere in its construction. The motor parts are finished in black enamel and striped in gold.

WESTERN ELECTRIC COMPANY.

The Western Electric Company's "Standard" ceiling fan is shown in Fig. 21 and Fig. 22. Fig. 21 is a cross-section view of the "Standard" ceiling fan. The motor is bipolar and has a slotted drum armature, the core being mounted directly on the shaft. The yoke and pole-pieces are one casting of semi-steel.

The armature winding is double silk-covered wire, wound in circular slots and insulated from the core by pressboard tubes and washers. The field coils are wound in four sections, each section being thoroughly insulated with a double wrapping of heavy insulating tape dipped in Sterling insulating varnish.

The "Standard" ceiling fans have been

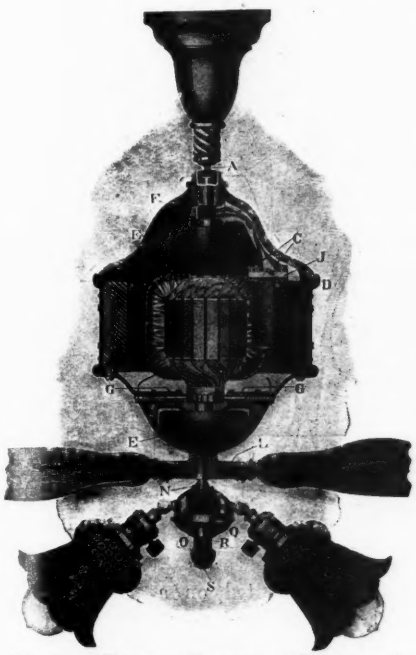


FIG. 21.—WESTERN ELECTRIC "STANDARD" CEILING FAN IN SECTION.

equipped with non-spillable oil reservoirs, so that the bearings are constantly flooded with oil. The well is partly covered and a flange extending from the top of the well nearly to the surface of the oil prevents the oil from spilling when the motor is laid on its side or even inverted. This leaves sufficient opening around the shaft to allow thorough washing of the wells with benzine at the end of the season. The brush-holders are of the cartridge type and the brushes graphite pencils pressed upon the commutator by a helical spring behind the brush. The spring is designed to give a constant pressure to the brushes until they are almost entirely used up.

The weight of the motor is supported by a strong cast-iron bracket fastened to the frame with machine bolts. The bracket also supports the upper bearing and a steel tube extending through the hollow armature shaft. This tube contains a six-wire cable made up of the leads for the chandelier lights and the wires connecting the speed-regulating rheostat to the switch.

The rheostat, giving three speeds to the fan, is made of German silver wire wound on an iron drum, the wire being imbedded in a coating of white enamel. The rheostat is mounted on a porcelain base screwed to the cast-iron bracket. The base serves as a connection board, having six binding-posts for connections of the chandelier lighting leads and rheostat leads.

The upper cover can be removed to get at the upper oil well and the connection board without taking the fan from the ceiling hook.

The bearings are of babbitt and are self-aligning. The large wearing surface of the journals and bearings, and rigid method of mounting the bearings, make it practically impossible for the armature to be drawn against the pole-pieces on account of imperfect alignment or wearing of the bearings.

The blades are of finest quality of white basswood, thoroughly seasoned and free from blemish.

The sweep of the blades is sixty inches; the width across the face eight and three-quarters inches. The fans run at a speed

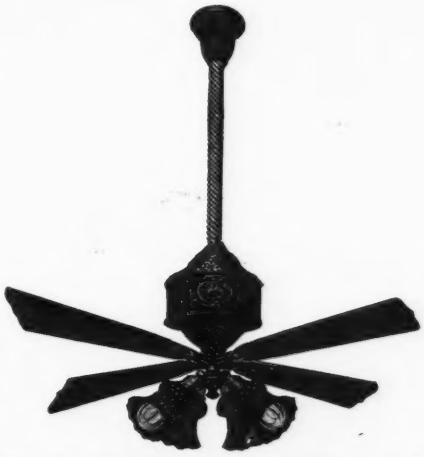


FIG. 22.—WESTERN ELECTRIC "STANDARD" CEILING FAN, WITH CHANDELIER ATTACHMENT.

of 210 revolutions per minute, and consume 120 watts.

These motors are wound for 110, 170, 220, 250 and 500 volts; the 170 and 250-volt motors are intended to run in groups of three and two in series on 500-volt circuits, in which case a wall switch rheostat for three-speed control is furnished.

Figs. 23 and 24 illustrate the Western Electric Company's "Western" ceiling fan for 1904. Fig. 23 is a cross-section view of the "Western" No. 1 ceiling fan; Fig. 24 is a perspective view of the "Western" No. 2 fan.

The "Western" No. 1 and "Western" No. 2 fans are similar in all respects, with the exception that the No. 2 is not provided with a starting switch. Both the No. 1 and No. 2 are single-speed fans. The bipolar motor has an armature similar to the Standard ceiling fan. The yoke is of best soft cast iron, having forged steel pole-pieces bolted to the casting. The field coils are wound on pressboard spools. The use of forged-steel pole-pieces, with carefully designed extensions having a large polar angle, al-

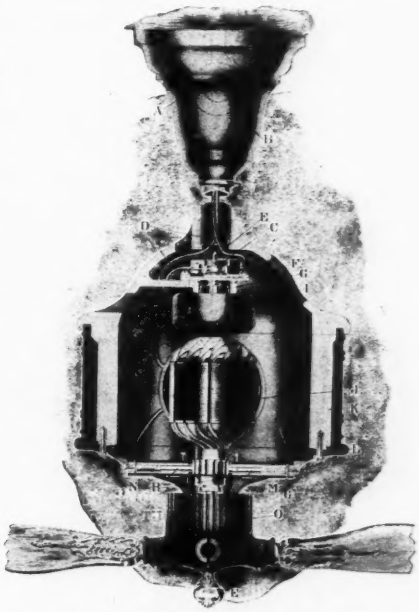


FIG. 23.—WESTERN ELECTRIC "WESTERN" CEILING FAN, IN SECTION.

lows the use of a field coil of small diameter, affording an exceptionally compact and efficient motor. The brackets supporting the upper bearing and switch and the upper cover into which the suspension rod screws, are cast integrally with the frame. The "Western" fans have also been equipped with oil reservoirs, but they do not have the non-spillable features of the Standard wells, although the method of lubrication is the same. Before removing the fan from the ceiling hook, the oil should be withdrawn from the wells by means of a small oil pump provided for this purpose. The switch in the upper part of the "Western" No. 1 fan is operated by a key and a rod extending through the hollow armature shaft.

The No. 1 motor operates on 110, 220

and 500 volts, while the No. 2 is designed to operate singly on 110, 170, 220, 250 and 500 volts, or in groups in series as follows:

2—110-volt fans on a 220-volt circuit.
5—110-volt " " 550-volt "
3—170-volt " " 500-volt "
2—250-volt " " 500-volt "

The blades are of white basswood, free from blemish, and have a sweep of fifty-four inches. The motors operate at a speed of 200 revolutions per minute with an electrical input of ninety watts.

The general appearance of the Western Electric desk fans for 1904 is similar to that of the well-known type of the past year. Fig. 25 is an external view and Fig. 26 a cross-sectional view of the desk fan.

The U-shaped field magnet with armature at the top allows a low pedestal to be used, thereby making the weight of the motor unusually low, as a large proportion of the material used is "working

FIG. 24.—WESTERN ELECTRIC "WESTERN" CEILING FAN, WITHOUT SWITCH.

material." The weight of the motor is further reduced by the use of a forged-steel field magnet having the best magnetic properties.

The armature is of the ironclad, drum type, wound with double silk-covered wire, insulated from the core by pressboard tubes in the slots and pressboard washers over the end-plates. The field coils are wound on pressboard spools and being exposed to the direct action of the moving air, an exceptionally low running temperature is ensured.

The commutator is made of hard-drawn copper segments, separated by best mica insulation. The bearing bracket enclosing the commutator end of armature is of such a form as to furnish ample protection from any dirt or dust falling upon the fan and liable to injure the moving parts, but is sufficiently open to allow the commutator to be readily inspected.

The bearing brackets encase the babbitt bearings and are provided with lips which overhang flanges on the commutator cap and on the fan hub to prevent throwing of oil. From the recesses in the

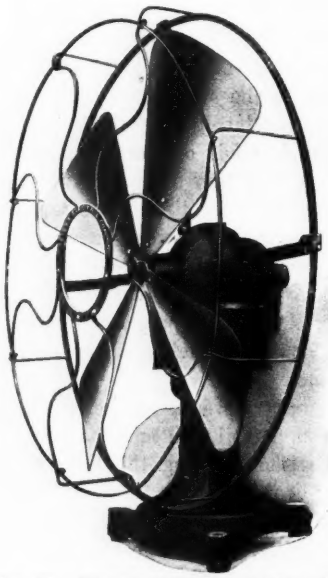


FIG. 25.—WESTERN ELECTRIC DESK FAN.

bearing brackets formed by the lips, the oil is drained back to the oil cups through ducts in the castings. A cap covers the

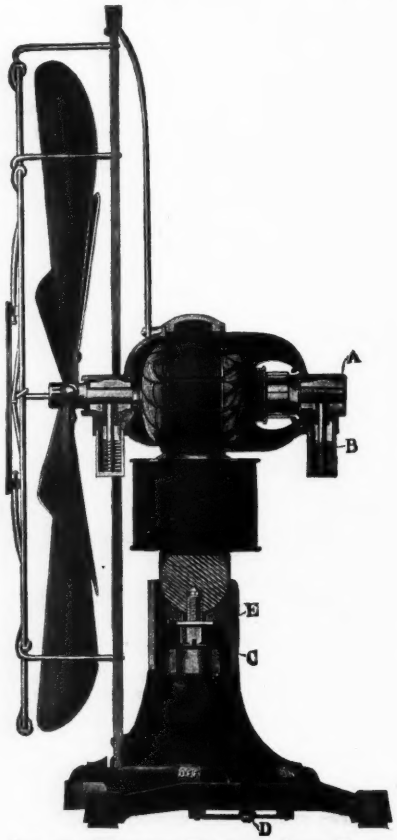


FIG. 26.—WESTERN ELECTRIC DESK FAN, IN SECTION.

end of the shaft and bearing and prevents leakage of oil and entrance of dust.

The brushes are of specially prepared graphite, circular in cross-section, and self-adjusting. The brush-holders are a modification of the cartridge type and are provided with triggers which bear upon the end of the brush, pressing it against the commutator. They allow almost the entire brush to be used up, and as there is no clamping they will not break the brushes. The brushes can be readily renewed, without disturbing any of the electrical connections.

The speed-regulating rheostat consists of an iron drum upon which is wound the best quality of German silver wire, embedded in and protected by a complete coating of white enamel, doing away with any possibility of short-circuiting or grounding with the adjacent frame. The

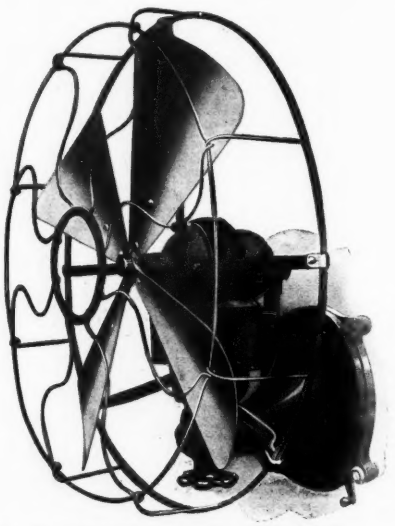


FIG. 27.—WESTERN ELECTRIC 12-INCH BRACKET FAN, WITH BALL AND SOCKET JOINT.

drum is mounted on a porcelain base carrying the speed-regulating switch and binding-posts.

These motors are wound for operation on standard direct-current circuits of 110, 220 and 500 volts. The field coils are connected in series with the armature for all voltages.

These motors are also made with the bracket form of mounting. The fan can be placed in any desired position by the adjustment of a single hand screw. The adjustment can be made while the fan is running at full speed. The motor frame swivels upon a ball and socket joint and has a horizontal range of 180 degrees and vertical range of forty-five degrees. Fig. 27 illustrates the bracket type.

FORT WAYNE ELECTRIC WORKS.

"Wood" fan motors, manufactured by the Fort Wayne Electric Works, are made in three styles, for use in different locations, and in three voltages, one for

direct current at 115 volts and another for 52 and 104 volts, alternating current, 60 and 140 cycles.

The first style of fan motor produced was a small stationary desk fan as shown in Fig. 28. This fan motor is exceedingly light for its output and makes a very neat appearance without taking up much room. It is furnished with a suitable length of lamp cord with Edison attachment plug for attaching to the lamp socket. The motor drives an eight inch four-blade fan at 2,200 revolutions per minute with a consumption of twenty watts in sixty cycles and direct current, and forty watts in the 140-cycle alternating-current motor.

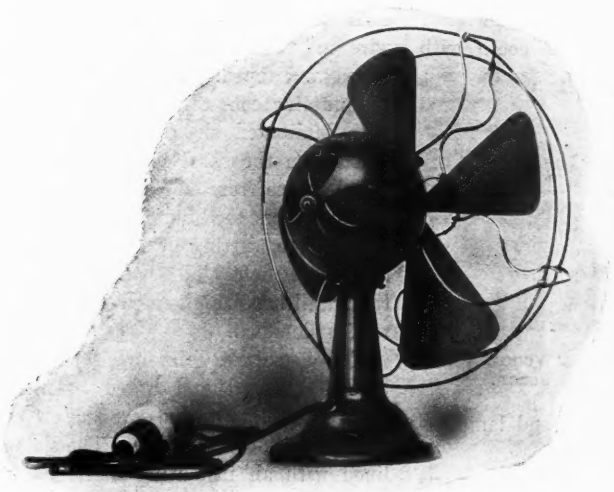


FIG. 28.—"WOOD" STATIONARY DESK FAN MOTOR.

The second style in which this motor is produced is shown in Fig. 29. This style is distinctly unique and attracted considerable attention when first introduced to the trade a few years ago. It is termed a "suspended revolving" motor. The motor proper of this type is identically the same as in the desk type, except in the position of the point of support for the motor. The desk type motor is mounted in such a position that the shaft is horizontal and at right angles to the pedestal. In the suspended revolving type the motor is attached to the bearing within the lower hemisphere of the hollow suspension shell. This attachment is made at such point that the shaft makes an angle of forty-five degrees with a horizontal and is also at the same angle with the vertical axis of suspension. At the lower end of the shaft this brings the upper fan blades further away from the axis of suspension than the lower blades. This, together with the fact that the backward pressure exerted by the fan tends to raise the motor, causes the whole motor to rotate about the axis of suspension due to the action of gravity acting in opposition to the repulsion of the blades which tends to raise the motor. The rate of rotation about the vertical axis varies of course with the speed of the fan and the angle of the blades. At a speed of 2,200 revolutions per minute the motor rotates about the vertical axis from twenty-five to fifty times per minute, depending upon the angle of the blades which can be varied at will by bending them slightly.

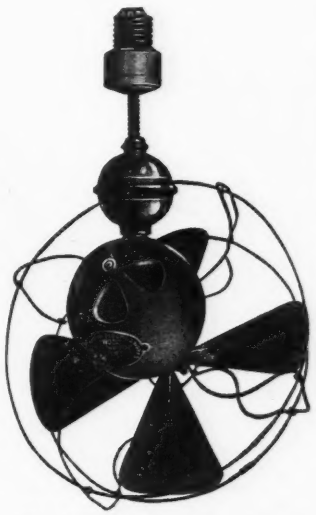


FIG. 29.—"WOOD" SUSPENDED REVOLVING FAN MOTOR.

The spherical case above the motor contains frictionless ball bearings on which the motor turns about the vertical axis. Current is delivered to the brushes of the motor through brushes bearing on small collectors mounted on the upper end of the suspension bearing within the small spherical case, as shown in Fig. 30.

The fact that these motors are suspended while in operation necessitates making it as light as possible. This is accomplished by constructing the enclosing shell and lower suspension sphere of aluminum alloy, which is amply strong enough for all strains and results in an exceedingly light motor.

The revolving type is built for the same circuits and is attached to the lamp socket in the same manner as the attachment plug for the desk-type motor. The revolving motor may be suspended from any convenient electric light socket on a chandelier, wall bracket or on a desk light standard.

FIG. 30.—BEARING CASE OF "WOOD" SUSPENDED REVOLVING FAN MOTOR.

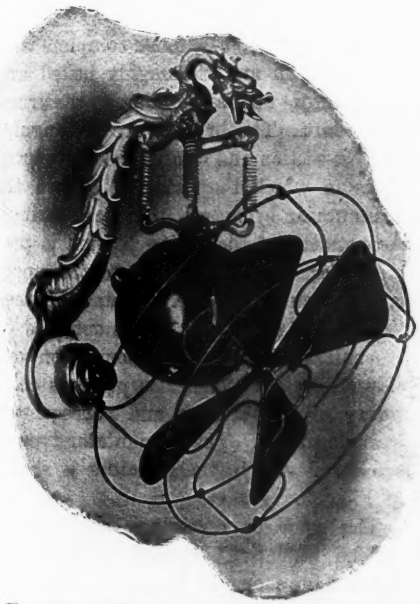


FIG. 31.—"WOOD" STATIONARY BRACKET OR TELEPHONE BOOTH FAN MOTOR.

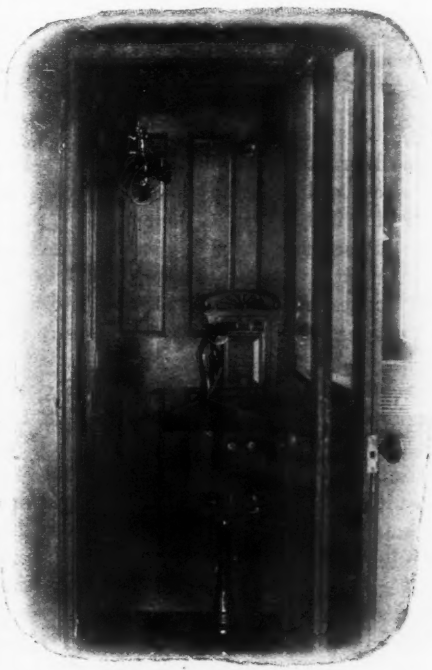


FIG. 32.—"WOOD" TELEPHONE BOOTH FAN MOTOR INSTALLED.

The third style in which "Wood" fan motors are made is illustrated in Fig. 31. As shown here the motor is intended for mounting directly on the wall or partition where silent running is essential. The

motor is attached to a three-arm spider which replaces the suspension bearing used with the revolving type. This spider is suspended from three points of support through tempered spiral springs properly adjusted to take up all vibration of the fan and preventing its reaching the wall through the bracket.

The special purpose for which this motor was designed was for use in telephone booths, where noisy operation is prohibitive. For this use these motors are of particular utility, and are being installed in large numbers in all sections of the country. The motor is very light and does not furnish too much breeze and is noiseless in operation. It is small enough to be mounted on the side of the cabinet and gives just the proper amount of breeze in the desired direction. It does not cause the slightest inconvenience to the telephone user by noisy operation or disagreeable vibration.

It may be swung about a vertical axis and clamped in any position by a small set screw in the suspension spider. The

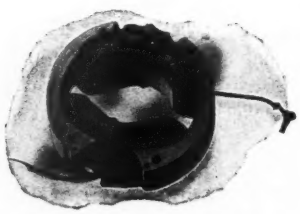


FIG. 33.—FIELD MAGNETS OF "WOOD" DIRECT-CURRENT FAN MOTOR.

wall bracket is hollow and encloses the wires leading from the motor to the switch in the base of the bracket.

These motors can be used in combination with a sixteen-candle-power 110-volt incandescent lamp on 110 or 115-volt direct-current circuit. When so used the lamp and motor are connected in series across the line with proper wiring arrangements to operate so as to light the lamp and start the motor by closing the cabinet door. The speed of the motor is suitably lowered for use in this service and the candle-power of the lamp is also slightly reduced from its standard rate. For example, the motor and lamp connected in series on 110-volt direct-current circuit will result in a speed of 1,100 revolutions per minute for the motor with twelve candle-power from the lamp. This reduction in the candle-power of the lamp is unobjectionable, in view of the fact that the fan motor will be used only during the summer when the demand for light is not so great as in the cold weather when the days are dark. The motor when used in this manner consumes practically no energy as the light will be necessary in any case and the refreshing breeze furnished to the user of the booth, together with the necessary light, is one of the greatest conveniences that has ever been incorporated in a telephone booth. Fig. 32 shows the equipment of the booth with

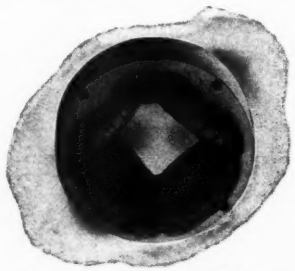


FIG. 34.—FIELD MAGNETS OF "WOOD" ALTERNATING-CURRENT FAN MOTOR.

"Wood" bracket fan motor and lamp arranged for series operation.

The construction of the operating parts of "Wood" fan motors of all types consists of two general styles. Direct-current and fifty-cycle alternating-current motors are of the commutator type, while the 140-cycle alternating-current motor is of the induction type. This results in separate armatures for the two distinctions. The field structure is also different, the direct-current and sixty-cycle alternating-current motors having a two-pole field structure with tapered pole tips, while the 140-cycle motor is provided with a four-pole field magnet equipped with copper shading coils to assist in starting. With these exceptions the following description of the construction of these motors will apply to all the types manufactured by the Fort Wayne Electric Works.

The field magnets are built up of stamped laminations. The shape of each can be clearly seen by referring to Fig. 33 and Fig. 34 which show, respectively, the direct-current or low-frequency and the

FIG. 35.—ARMATURE OF "WOOD" DIRECT-CURRENT FAN MOTOR.

high-frequency field magnets. The figures show a complete magnet with its coil, ready for insertion in the spherical shell which encases the field structure and which forms a support for the bearing and brush mechanism and by which it is supported or suspended.

The field laminations are individually japanned before being assembled and are riveted together with German silver to reduce eddy current to a minimum. The magnet poles have projecting tips and the coils when pulled into place and bent into shape, shown in the engraving, are drawn into recesses above the pole tips. The coils are form-wound with silk-covered wire and after construction are shellaced, baked and taped. The armature of the commutator construction is drum-wound with laminated slotted discs which are twisted on the shaft to give the slots a spiral course from end to end of the core and to prevent the humming due to abrupt and forcible cutting by the coils through the magnet field. This is a common practice in all small high-speed motors and is well understood.

The armature coils are form-wound, taped, shellaced and baked before and after assembling on the core and are composed of silk-covered wire. The slots are lined with an insulating fabric and the coils are held by suitable wedges in the upper part of the slot.

The commutator of the direct-current or low-frequency motor is separate from

FIG. 36.—ROTOR OF "WOOD" ALTERNATING-CURRENT FAN MOTOR.

the armature and assembled complete with its insulation and thoroughly baked and tested before final assembling on the armature shaft. The brushes are rectangular in cross-section and located in square brass tubes in which they are fed toward the commutator by means of helical springs. Adjustment of the spring tension is provided for in a screw set into the upper end of each brush tube. Contact between the brushes and brush box is obtained by a small sliding pressure spring on one side of the box which also prevents chattering of the brushes and consequently wear and noise. The commutator type of armature used in these motors is shown in Fig. 35.

The rotor or revolving element used in the induction type of "Wood" fan motor is, as shown in Fig. 36, composed of laminated punchings assembled on a spider mounted on the shaft. The discs of the rotor are twisted around the shaft so as to spiral the slots. The conductors consist of uninsulated copper rods connected in parallel as usual by a ring at each end of the core structure.

THE FIDELITY ELECTRIC COMPANY, INCORPORATED.

The Fidelity Electric Company, Incorporated, Lancaster, Pa., is placing on the market the well-known line of desk, ceiling and bracket fans formerly manufactured by the George C. Towle Manufacturing Company. This line of fans has been brought up to date, and a novel addition is in the form of the "Eclipse" socket fan. One of the fans made by this company is shown in the accompanying illustration. This is the type H direct-current sixteen-inch desk fan.

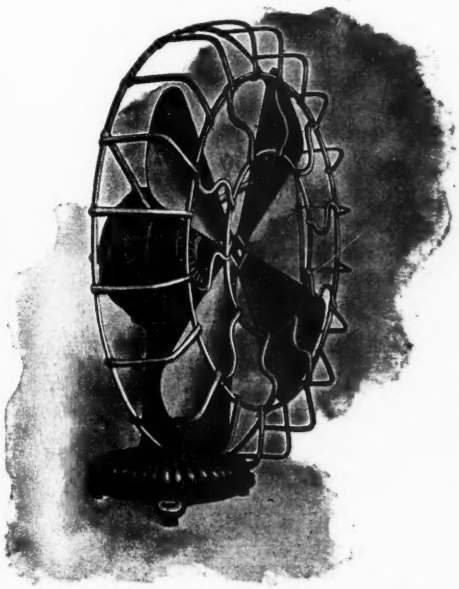


FIG. 37.—"ECLIPSE" DIRECT-CURRENT DESK FAN.

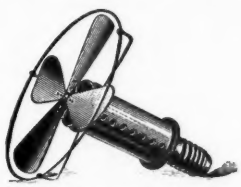


FIG. 38.—"ECLIPSE" SOCKET FAN.

FIG. 39.—"ECLIPSE" SOCKET FAN.

The motor body of this fan is constructed of cast steel of high permeability. The fields are form-wound, and before being taped are dipped in a specially prepared insulating compound. The bearings are made of the best phosphor-bronze, and wick-feed oilers are used. The entire fan has only four pieces of casting, *viz.*, the motor body, two bearings and the base. It can be entirely disassembled by simply unscrewing two long screws which hold the bearings in place.

The socket fan is shown in the accompanying illustrations. The construction is of the bipolar salient pole type, with one field coil. The magnet core is cylindrical, and the pole tips are curved drop forgings which project from each end of the magnet core. The magnet is composed throughout of the best grade of Norway iron, and, complete with the core and tips, forms a split tube. One end of the magnet core carries the field coil, and the other end the armature. The armature is of regular construction and has twelve sections wound with silk wire. The commutator is filled throughout with mica, and is built as carefully as on large machines.

The fan has an eight-inch sweep, and the motor can be screwed directly into an ordinary lamp socket, without a plug or cord. It consumes eleven watts, or five can be run with the same amount of current consumption as an ordinary sixteen-candle-power lamp. The speed is 1,600 revolutions per minute, and it is built only for 110 volts, direct-current.

ECK DYNAMO AND MOTOR WORKS.

The Eck "Universal" fan motors, manufactured by the Eck Dynamo and Motor Works, Belleville, N. J., have been well known for a number of years. Recently the company has been offering a new "Universal" fan motor, which has the distinctive characteristic of being interchangeable at once from a desk pattern into a wall or bracket fan. In addition to this there is added an oscillating device which accomplishes a wide distribution of the air blast. This oscillation does not depend upon air reaction, but is controlled with a simple, positive direct drive. Changes and adjustments to regulate the arc and speed of oscillation are quickly and easily made, without the use of a screw-driver or wrench.

The fan is equipped with a ball and socket joint between the motor stem and the base, which permits of quick adjustment, so that the general direction of the breeze can be regulated to suit varying height of desks, window ledges, counters, or wherever the fan may be set.

Fig. 40 shows this apparatus used as a desk fan, and Fig. 41 shows the same apparatus converted into a bracket trunnion oscillating fan.

Special care has been exercised in designing the fan blades, so that they will have a high propelling force and, at the same time, run with a minimum of noise. The blades are cut from very heavy sheet brass, and are securely riveted to a strong cast spider or hub.

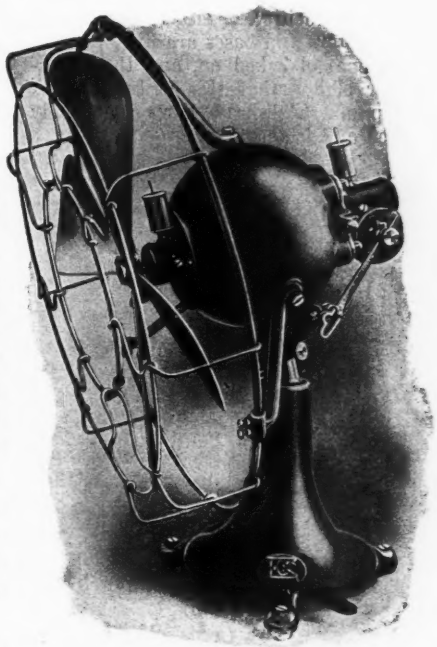


FIG. 40.—ECK "UNIVERSAL," AS A DESK FAN.

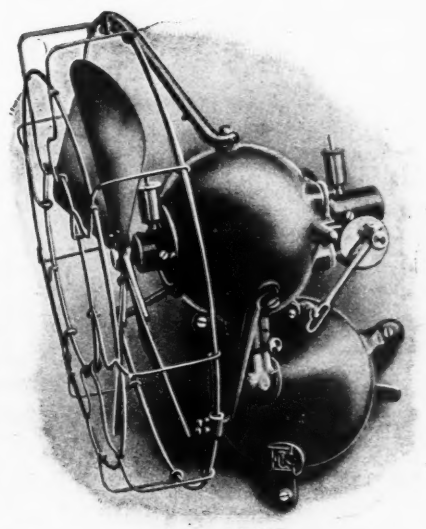


FIG. 41.—ECK "UNIVERSAL," AS A BRACKET FAN.

The fan guard is particularly strong and rigid, and the attachment braces are cast with ribs which hold the guard in a fixed position.

For oiling, an automatic grease cup is used, doing away with the wick-feed de-

vice. One filling will run the fan for an entire season, and the bearings are made of phosphor-bronze and are self-aligning.

The brush-holders are so designed that they can not at any time come in contact with the commutator. Special attention is called to the simplicity of the brush-holder, a change of carbon being made with great facility.

The motors and bases are finished with bicycle enamel baked on, and the manufacturer claims that this will not crack or chip off. All brass parts are highly polished and lacquered.

COLONIAL FAN AND MOTOR COMPANY.

The Colonial Fan and Motor Company, Ravenna, Ohio, is a well-known manufacturer of direct-current fan motors. These

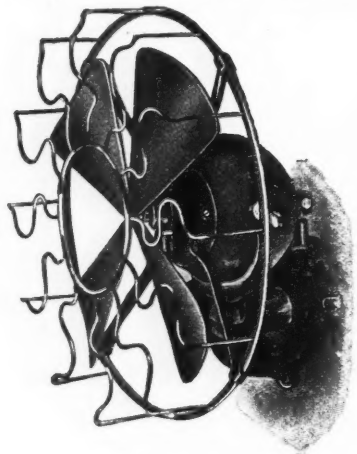


FIG. 42.—COLONIAL TRUNNION BRACKET FAN.

are made in both trunnion and swivel types, for desk and bracket fans, and several styles of ceiling fans are made, with and without electrolier attachments.

Fig. 42 shows a trunnion bracket fan, and Fig. 43 shows a ceiling fan without electrolier attachment.

In the desk and bracket fans, which are designated as type "S," the armature core is composed of steel discs slotted to admit the armature coils. The commutator segments are properly insulated from each other with the best quality of mica, and the armature leads are inserted into the segments below the wearing surface. The commutator segments are made from the best grade of drawn copper, and are securely fastened together.

The bearings are composed of phosphor-bronze, self-aligning and requiring very little lubrication.

The blade hub is cast in one solid piece of brass, and the blades are of heavy spring brass, highly polished and lacquered. The guard is made very rigid, and is held in place by four malleable iron braces.

The speed regulator consists of a rheostat located in the fan base, and is made up of porcelain, asbestos and German silver wire. The capacity of the rheostat is sufficient to prevent undue heating, and gives the fan three distinct speeds and a cutout.

Carbon brushes of large dimensions are used, and these are controlled by compression springs.

The blade guard, brush-holders and other parts are highly polished and lacquered. The body of the fan is finished with three coats of black enamel, varnished.

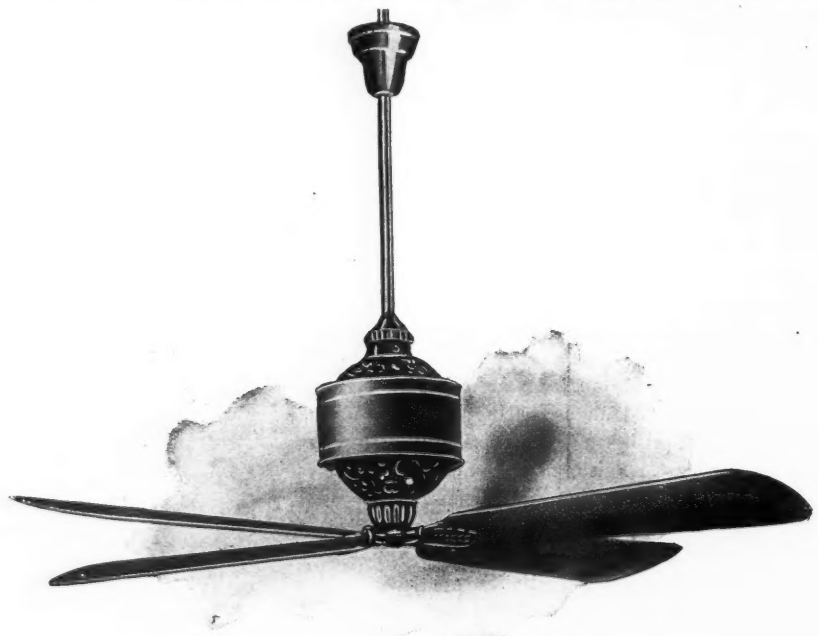


FIG. 43.—COLONIAL CEILING FAN, WITHOUT ELECTROLIER ATTACHMENT.

The ceiling fans, which are designated as type "R," are finished in either polished brass or oxidized copper. The blades are eight and one-half inches wide, interchangeable, and are made of well seasoned wood. They have a sweep of sixty inches from tip to tip.

Phosphor-bronze self-oiling and self-aligning bearings are used, and the construction of the lubricating device is such that the bearing parts are constantly immersed in oil, the receptacle holding oil sufficient to last for an entire season.

The brush-holder consists of a round brass shell or tube, enclosed in an insulated sleeve, and is held in position by means of a clamp secured by screws.

The armature is built up of sheet-steel laminations, and the windings are carefully insulated from the core and armature, the insulation being subjected to a breakdown test of 1,000 volts. These ceiling fans are equipped with a regulating switch allowing two distinct speeds and a cutout. The body of the switch is placed in the top of the fan, and is operated by means of a key located at the bottom of the fan.

THE CENTURY ELECTRIC COMPANY.

The Century Electric Company, 1007 to 1011 Locust street, St. Louis, Mo., calls attention to the "Pillsbury" alter-

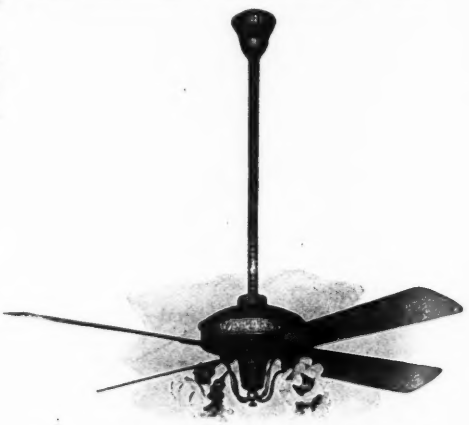


FIG. 44.—CENTURY ELECTRIC COMPANY "PILLSBURY" ALTERNATING-CURRENT CEILING FAN.

nating-current ceiling fan. This is a single-phase, self-starting, direct-connected fan. The only operation necessary to start it is to turn the switch.

The motor is of the induction type, and there is no insulated wire on the armature, except in the starting device, which is a small secondary motor inside the running motor. There are two polar projections in the upper or stationary part, which form the field of the starting motor. The coils on the three lower poles are connected in star to form the armature. Between each two poles is a brush-holder connected to the adjacent coil, pressing a brush against the two-part

commutator. This is, respectively, F and G in the accompanying illustration. The connections of the starting motor are from the line through one coil to one segment of the commutator, through the armature to the other segment, and then through the other field coil back to the line.

The brush-holder consists of a heavy casting carrying a carbon brush which is pressed on the commutator by a spring. The commutator is stationary, while the brush revolves. When the armature reaches the proper speed, the centrifugal force of the heavy brush-holder overcomes the tension of the spring and lifts the brushes from the commutator. This opens the circuit in the starting motor and relieves all brush friction, allowing the running motor to carry the load. As soon as the motor stops, the brushes again press on the commutator, ready to start.

The letters in the illustration have the following identity: A, cover; B, hook; C, insulator; D, shaft; E, felt; F, brush-holder; G, commutator; H, starting coils; I, armature core; J, field core; K, oil cup; L, set screw; M, hardened steel washers; N, hardened steel balls; O, leather washer; P, nut.

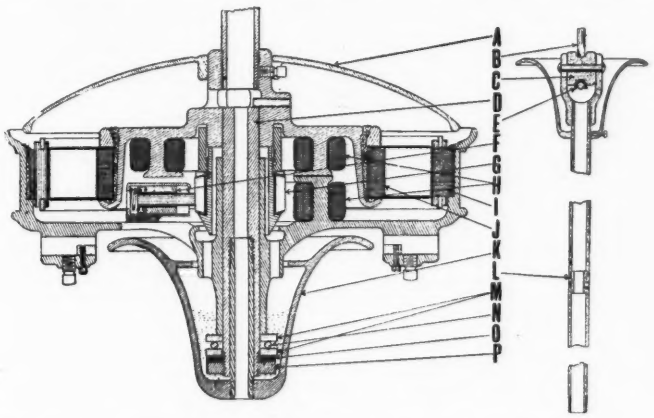


FIG. 44A.—CENTURY ELECTRIC COMPANY, "PILLSBURY" ALTERNATING-CURRENT CEILING FAN.

The bearings and shaft are fitted so that there is no binding or sticking, and no chatter or vibration. The shaft is of such length as to prevent the armature tilting and striking the stationary field. The weight of the armature is supported on ball bearings immersed in oil. The motor may be oiled by pulling out the switch stem and screw, and taking off the oil cup. If any of the oil works out over the top of the bearing, it is carried down the inside of the commutator spool into the recess in the armature, where it finds its way back into the oil cup.

Each fan is equipped to operate at two speeds. The motors are wound for 104 volts and 7,200 alternations, but may be used on circuits from 100 to 110 volts. They can be wound to order for any voltage and any frequency below 8,000 alternations.

THE EMERSON ELECTRIC MANUFACTURING COMPANY.

The Emerson Electric Manufacturing Company, St. Louis, Mo., will show a strong line of fan motors for alternating current. These will include, in addition to the well-known types of "Emerson" fan, a new line which is designated as the "Trojan." The 1904 selection of "Emerson" motors will include types for every class for low-frequency service and many for high alternation systems. A new fan which this company is manufacturing

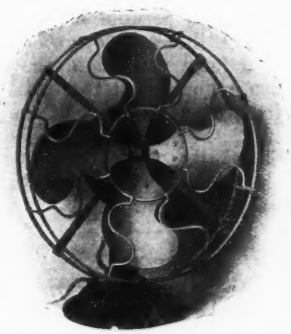


FIG. 45.—"EMERSON" SWIVEL DESK FAN.

FIG. 46.—"EMERSON" TRUNNION BRACKET FAN.

is an especially quiet low-frequency exhaust fan, which has been added to the list of regular "Emerson" exhausters for 60 and 133 cycles and for direct current. The accompanying illustrations show in Fig. 45 the "Emerson" swivel desk fan with distinctive "Parker" blade. Fig. 46 shows the "Emerson" trunnion bracket fan, and Figs. 47 and 48 show, respectively, the "Trojan" desk fan and "Trojan" four-blade ceiling fan, with electrolier attachment. The "Emerson" desk fan has a one-half inch hardened steel shaft, automatic starting device, and has a very efficient form of field winding. Special attention is paid to the oil distribution in the "Emerson" fan and the arrangement is such that it is impossible for oil to be thrown from the fan-blades. The "Trojan" desk and bracket fans are built upon the same mechanical and electrical principles as other alternating fan motors now on the market. They are equipped with the usual style blades, are self-starting, have two speeds and will start on either speed. The switch is located in the base, where it is easy of access.

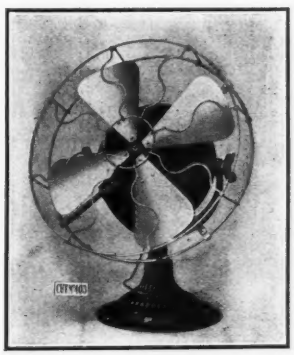


FIG. 47.—"TROJAN" DESK FAN.

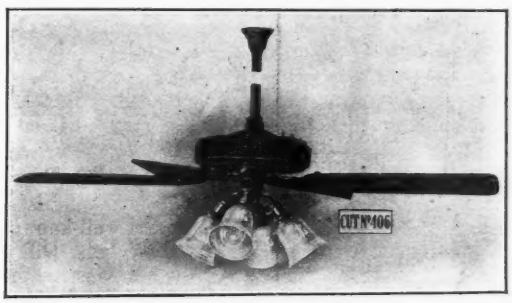


FIG. 48.—"TROJAN" CEILING FAN.

JANDUS ELECTRIC COMPANY.

The Jandus Electric Company, Cleveland, Ohio, will manufacture, as usual, both alternating and direct-current fans in twelve-inch, fifteen-inch and sixteen-inch sizes for 1904. The company states that, although last summer's weather was the worst fan weather in years, its sales were greatly increased. The company makes a specialty of enclosed and dust-proof motors, and claims as principal features, high electrical efficiency, fine me-

chanical work and anti-friction thrust bearings. It is calling special attention to a twelve-inch alternating-current fan of a slow speed, running noiselessly, for household use.

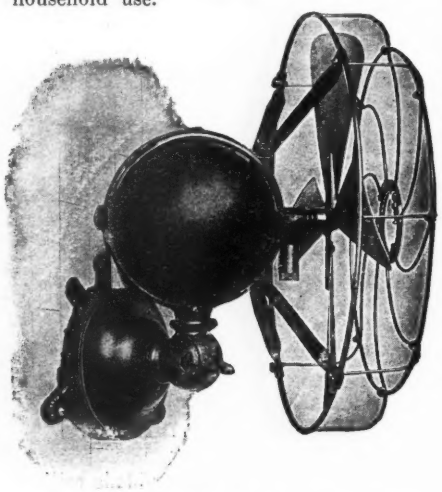


FIG. 49.—JANDUS ELECTRIC COMPANY, TRUNNION BRACKET FAN.

A specialty which the company introduced last year is the "Gyrofan," an illustration of which is shown herewith. This consists of two Jandus fan motors, pivot-

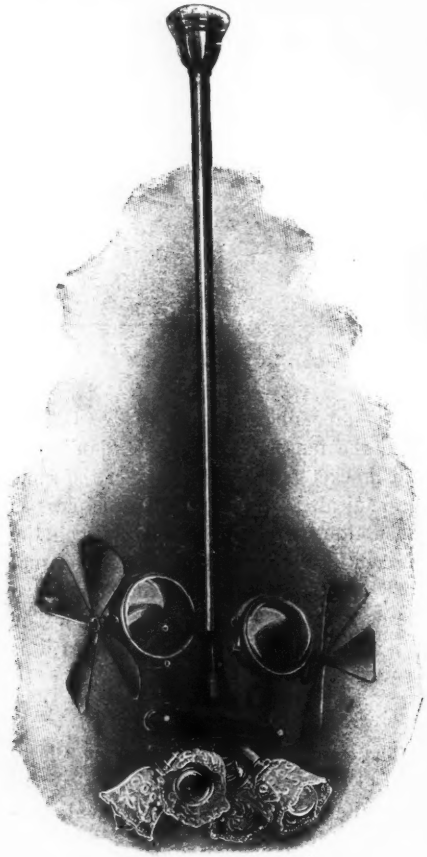


FIG. 50.—JANDUS ELECTRIC COMPANY, "GYROFAN"

ally mounted on a frame which is arranged to revolve about a vertical axis on a ball bearing. This pivotal mounting affords a means for governing the speed of the horizontal revolutions of the fixture. The adjustment is accomplished by employing two milled adjusting screws. The two motors, wired in multiple for 100 to 120-volt circuits; in multiple or series, as may be preferred, for 200 to 250-volt circuits, and in series for higher voltages, are connected to the circuit through copper slip rings and bronze contacts. A small wrist joint permits the blast from the fans to be directed downward, as desired. The force utilized in the revolution of the motors about the vertical axis results from an adjustment of the motor shafts with respect to the plane of the vertical axis of the fixture. The "Gyrofan" is made both with and without an electrolier attachment.

THE HUNTER FAN AND MOTOR COMPANY.

The Hunter Fan and Motor Company, of Fulton, N. Y., manufacturer of the

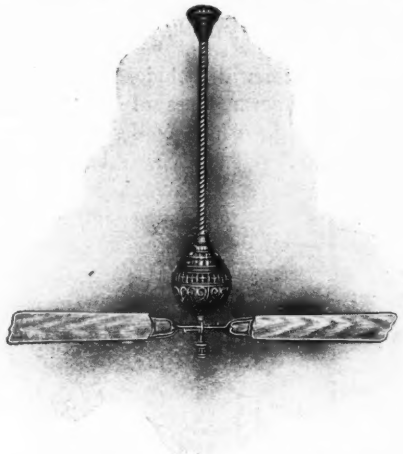


FIG. 51.—"TUERK" ALTERNATING-CURRENT TWO-BLADE CEILING FAN.

well-known "Tuerk" alternating-current fans, will make no change in design or construction. These fans have been popular for some years, and will include the

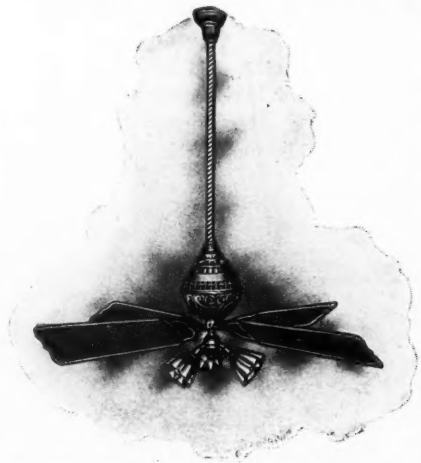


FIG. 52.—"TUERK" ALTERNATING-CURRENT FOUR-BLADE CEILING FAN.

improved ceiling fans which were shown for 1903. These are a two-blade electrolier fan and four-blade ceiling fan, which are shown in the accompanying illustrations. E. B. Latham & Company, 39 Vesey street, New York city, are the general agents for the "Tuerk" fans.

Cord Adjusters.

The accompanying illustration shows the "Crown" hard-rubber cord adjuster manufactured by J. H. Seaman, 175 Dearborn street, Chicago, Ill. As may be seen from the illustration, the "Crown" cord adjuster is easily placed on the cord

HARD-RUBBER CORD ADJUSTER.

without removing the sockets, obviating slipping and preventing abrasion of the connections. These adjusters are handled by supply dealers in every city, and are in extensive use in factories, mills, offices and other buildings. The manufacturer will be pleased to send a sample on request.

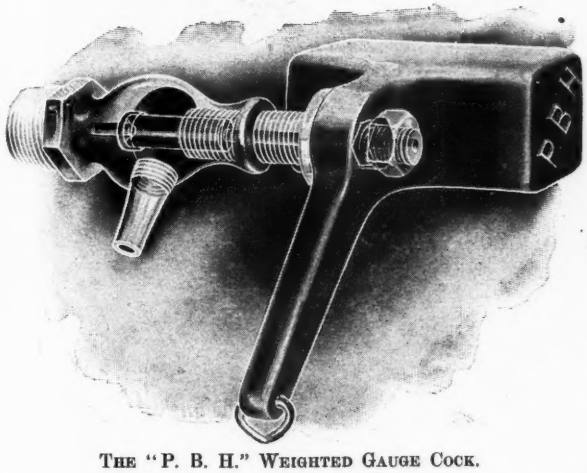
All Trains Electrically Lighted.

The Chicago & Alton Railway was the first line to run Pullman sleeping cars, dining cars and chair cars. The C. & A. was also the first line to establish a modern surgical system and the first, and so far the only line, to equip all of its locomotives with electric headlights. This leading thoroughness is to be immediately supplemented by the equipment of all cars in all trains with electric lights. Mr. C. A. Goodnow, the "Alton's" new general manager, has ever been regarded as the exponent of electric lighted trains, and has selected for the "Alton" a system by which the current is to be produced by the modern method of a dynamo driven by the axle during the run of the train.

F. F. Proctor is announcing that all of his theatres are fully equipped with telephone service and electrical apparatus and that at the recent investigation of the New York theatres by officials of the health, fire and police departments, only minor changes were ordered at the houses bearing his name. At Mr. Proctor's Fifth Avenue Theatre he has established a novelty in the opening of a waiting room in the new lobby, where one may command every attention without entering the theatre. Special arrangements have been made to provide for messenger calls and telegraphing.

The "P. B. H." Weighted Gauge Cock.

This cock is little more complicated or expensive than the simplest ordinary cock of the better grade. The seat is made in the body of the valve and is closed by a pencil of tin and antimony carried in the inner end of the triple-threaded stem. When the chain attached to the arm upon this stem is pulled, the stem is rotated sufficiently to cause the coarse pitched thread to withdraw the pencil from the seat sufficiently to open the cock and when the chain is released the weight rotates the stem in the other direction, forcing the end of the pencil back upon the seat. The pencil is so much softer than the seat that it is cut into by the edge of the latter, making a tight closure, no matter how gradually the cock may be closed. The portion of the stem which passes through the weighted lever is made hexagonal, preventing the lever, which has a corresponding hexagonal opening, from turning upon it. When by reason of the wearing away of the pencil, the position of the lever when the valve is closed becomes abnormal and the weight will not reseat the valve, it may be readjusted by removing the nut shown and turning the lever to another position on the hexagon. About three-quarters of an inch of pencil is provided outside of the stem, and when this has been used up, another can be inserted at the expense of a few cents. A hole one-quarter inch in diameter is bored through the centre of the stem to allow the imbedded end of the old pencil to be drawn out. This arrangement affords a cock which for long periods needs no repairing or attention other than occasional adjustment at long periods of the weight. It is obtainable from the inventor, P. B. Huyette, 1225 Betz Building, Philadelphia, Pa.



THE "P. B. H." WEIGHTED GAUGE COCK.

Underground Cables in Baltimore Fire.

The Baltimore fire has been the unfortunate means of settling many disputed points for the engineers of this country, and it has, among other points, emphasized most forcibly, in the minds of the interested observers, the superiority of underground cables for electrical transmission of power, as compared with old overhead methods.

The Standard Underground Cable Company has installed during the past few years in Baltimore many miles of underground cable, in the municipal subway for the Western Union and Baltimore & Ohio telegraph companies, the Maryland Telephone Company, the city fire and police departments and the United Railways and Electric Company. The main conduit lines run the entire length of the burned district and the manhole covers were in many cases covered with piles of hot brick and stone to a depth of twenty feet.

In spite of the intense heat, there is, so far as is known, not a single instance of trouble on the cables in manholes or subway except where exposed ends of cables were destroyed by fire, and the cable system is in perfect condition today.

Two three-conductor cables installed for the United Railways and Electric Company over a year ago and which terminated in the new and unburned portion of the Pratt street power-house, extended the entire length of the burned district, and were carrying current to the substation at 13,000 volts, the second day after the fire, without any interruption to service.

Free Lectures.

The Board of Education, New York city, N. Y., has arranged under the direction of Mr. Henry M. Leipziger, supervisor of lectures, courses of free lectures to be held during March and April, 1904, on astronomy, biology, electricity, physics and "first aid to the injured." The course in electricity will consist of eight lectures to be given by Mr. W. W. Ker at Alfred Corning Clark Neighborhood House, Cannon and Rivington streets. Information as to where the other lectures will be held may be had by applying to Mr. Leipziger.

Losses in Porcelain Insulators.

The London *Electrician,* in its issue of February 19, gives a brief abstract of an article on "Losses in Porcelain Insulators," contributed to a German paper by Herr R. M. Triese. The author says that porcelain insulators may be regarded as small capacities, the two sides of which are formed by the holder and the wire, respectively, the dielectric being the porcelain. In conducting these tests, a large number of insulators connected in parallel are suspended head downward in a bath of water, connected to one terminal of a testing transformer. The surface of the water is parallel to the neck of the insulator. The holes in the insulators provided for the supports were filled with water, and metallic connection made in this way with the other terminal of the transformer. Two types of insulator were tested, the first possessing a double petticoat and weighing 3.44 pounds. The frequency of the supply was fifty cycles per second. With an impressed voltage of 5,000, the insulator loss was 0.0295 watt. At 20,000 volts it was 0.606 watt. At 40,000 volts it was 2.99 watts, and at 50,000 volts the loss amounted to 4.975 watts. Tests on a newer type of insulator with four petticoats and weighing two pounds gave the following results at the same frequency: with an impressed voltage of 5,000, the loss was 0.025 watt. At 20,000 volts it was 0.392 watt. At 40,000 volts was 1.568 watts, and at 50,000 volts the loss was found to be 2.45 watts. The capacity of the first insulator was 0.0000296 microfarad, that of the second being 0.0000264 microfarad.

Allis-Chalmers-Bullock Organization.

The Allis-Chalmers Company has entered into an arrangement with the Bullock Electric Manufacturing Company, whereby the business of the latter will be taken over, and the business of both companies carried on as that of a single interest.

The business of the Bullock company will be conducted as heretofore by its present management under the form of a new Bullock Electric Manufacturing Company, organized under the laws of the state of Ohio, with George Bullock as president and Joseph S. Neave as vice-president.

This combination will give the Allis-Chalmers Company the facilities of a well-organized electric manufactory and the Bullock company will have for its electric generators the four prime movers, the reciprocating steam engine, steam turbine, gas engine and hydraulic turbine, now constructed by the Allis-Chalmers Company.

The Evolution of the Dale Company.

The Dale Company, of New York city, is probably one of the best-known supply houses in the country for electric lighting fixtures and staple accessories. Its reputation and successes are due to its president's, Mr. John H. Dale's, experience and knowledge of the business and all its details and particular requirements, and to perseverence and energy under strict adherence to sound business methods. The company, by its record of growth and progress, adds an interesting chapter to our history of industrial development and expansion.

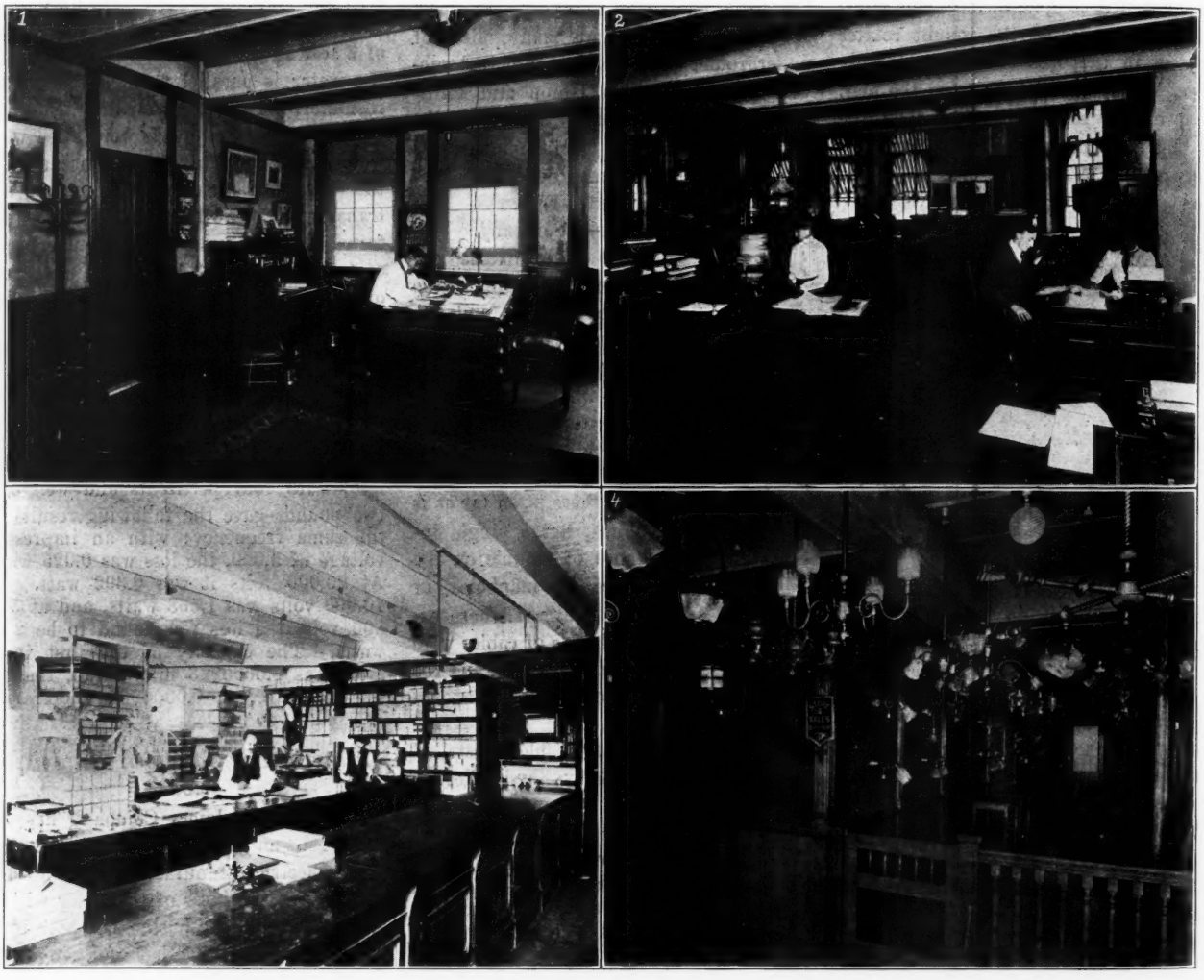
Mr. John H. Dale, having received his first and thorough training in the construction department of the old United States Illuminating Company, started in business for himself on September 15, 1888, in a small shop fifteen by twenty-five feet, on Fulton street, New York city, under the name of the Dale Manufacturing Company. This most modest beginning proved successful through Mr. Dale's untiring personal efforts, without any other help, and in 1890 the business was moved to larger quarters at 22 Cortlandt street, where the first help was employed to assist him in filling the increasing orders which he had secured. In 1896 a second move was necessitated into still larger quarters at 22 Thames street.

At first Mr. Dale devoted himself mostly to small construction work and the repairing of motors and dynamos. He soon, however, began the manufacture of portable lamps, cluster fixtures and brackets for local contractors.

Shortly after the establishing of new quarters in 1896, Mr. Dale began making extended trips through the eastern, New England and middle Atlantic states, and by bringing his goods to the direct attention of the supply men and contractors in the various cities, built up a considerable business. This policy was continued and extended until there were six traveling salesmen employed, who extolled the merits of the Dale fixtures and specialties, and placed them in stock with the supply dealers in every prominent city in the United States. After about four years of this kind of work the goods were introduced and it was possible to dispense with the traveling salesmen and maintain the now-created large demand for the company's specialties through extensive catalogue work and correspondence.

Mr. Dale, during this time, had personally visited every city in the United States, and in 1900 he made a trip to Europe, setting up an automatic sign apparatus at the Paris Exposition, for which he received a medal and diploma. He also traveled through Austria, and made a number of important contracts for the importation of gas and electric shades.

In April, 1903, the Dale Company moved to its present spacious quarters, where it now occupies two floors of the modern business building at Ninth avenue, Thirteenth street and Hudson street, and here it employs some 150 people.

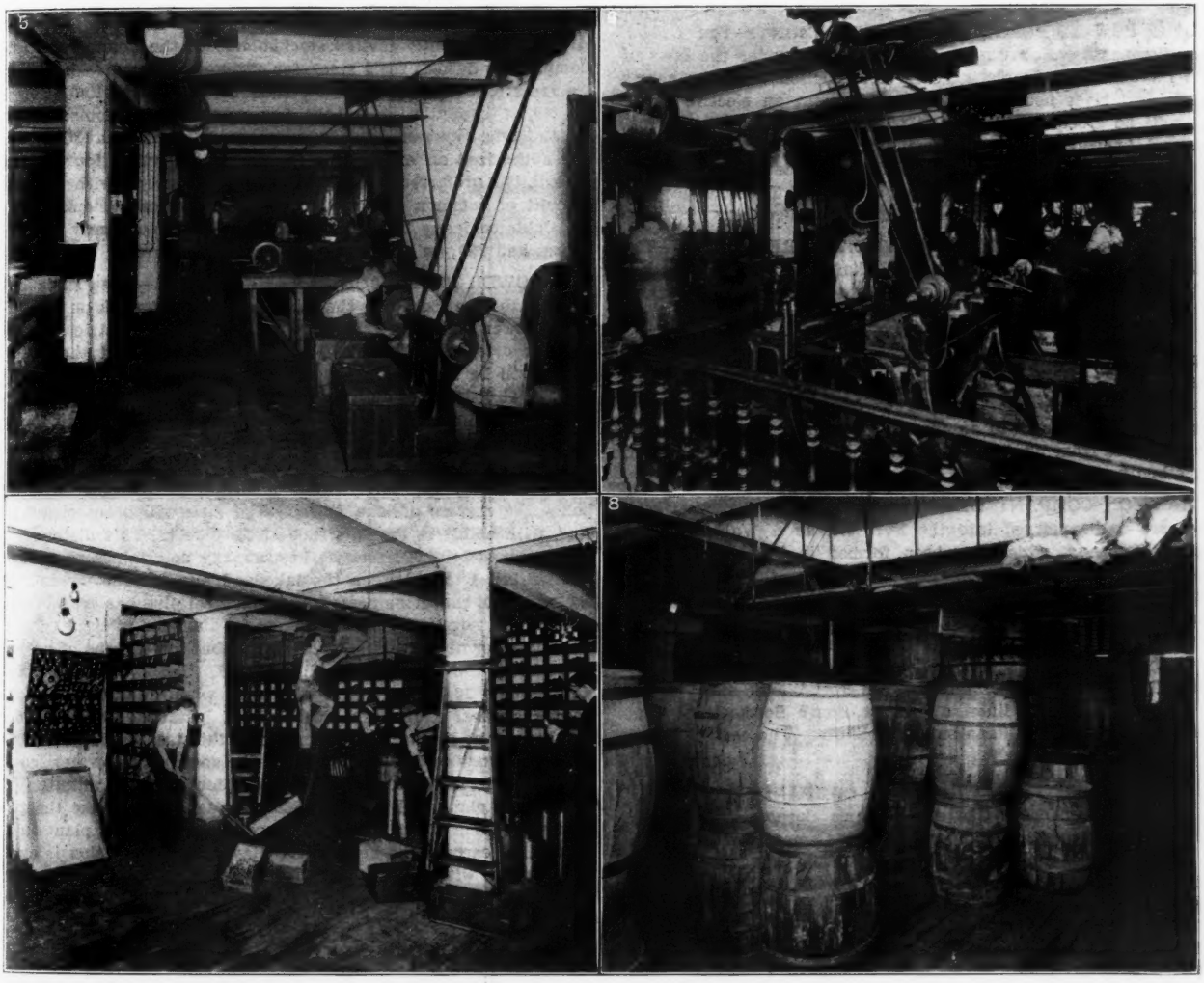


1.—The Private Office of Mr. John H. Dale, President of the Dale Company, New York City. 2.—General Office. 3.—City Sales Department. 4.—Reception Hall.

The accompanying illustrations give a fair impression and presentation of the magnitude of this manufacturing establishment. The lower floor of the two occupied by the Dale Company is given up to the offices, show-room, assembly and shipping departments, the floor above being given up entirely to manufacturing. Altogether there is occupied about 30,000 square feet of floor space.

A supporting evidence of the growth of the company can be afforded by a comparison of the original eight-page pamphlet and the present-day 136-page catalogue. The company was probably the pioneer in the introduction of aluminum for reflectors and shades, and it has built up an immense business in this line. The name of the company, however, has for a number of years been associated with a regular standard line of staple fixtures, fixture parts, supplies and accessories. A distinct departure is now being made in the specialties which the company is placing on the market. This new line will simply be an extensive addition to the well-known and established regular line of Dale fixtures and Dale specialties. The new line will consist of fixtures of the more highly ornamental and costly nature, suitable for installation in modern residences, clubs, offices, halls, restaurants, etc., wherever taste, style and artistic effect are desired. The goods will be catalogued separately, and will appeal to a distinct and exclusive class of trade. These fixtures, which the company is now exhibiting in its attractive, inviting and well-appointed display rooms at Ninth avenue, Hudson street and Thirteenth street, are worked up in many handsome and striking designs, and the beauty of the devices is of such variety and number as to meet almost any taste or requirement. The stamping, spinning and brass turning for the production of these new designs are all carried out in the manufacturing department. The different departments are completely equipped with the most modern machinery, apparatus and tools for the perfect production of these fixtures and their component parts. An improvement of the wireless cluster is now being placed on the market, and this is destined to become one of the most active-selling specialties which the company has ever produced.

The entire extensive establishment, with its show-room, offices, manufacturing and finishing departments, tool-rooms, etc., is conducted on a well-defined and especially adapted system and organization, and a visit and inspection will indeed prove interesting.



5.—Polishing Department, Dale Company. 6.—A Corner in the Manufacturing Department. 7.—The Supply Department. 8.—Raw Material and Shipping Department.

Electric Motors Wanted in France.

It is reported that Mr. George H. Jackson, consul, La Rochelle, France, has received numerous enquiries for prices on small electric motors, ranging from one-twelfth to one-tenth horse-power. The motors should be as compact as possible and capable of running in two directions. Prices should be submitted for sample of one and in lots of 100 and 1,000.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ASSEMBLY PASSES BILL GIVING AWAY FRANCHISES—A bill introduced by Assemblyman Thompson, of Niagara, extending the time for the Niagara, Lockport & Ontario Power Company to commence its work, and practically giving to the company the right of eminent domain, passed the New York state assembly recently. The bill received ninety-three votes in the affirmative and thirty-one in opposition.

MINE POWER PLANT AT HELENA, MONT.—The Oxbow Power Company, which was recently organized under the laws of South Dakota, is contemplating early construction of a dam across the Missouri river near Helena. At this point an electric power plant will be erected, and current will be transmitted to Helena, Butte and Anaconda mines and smelters. The work is expected to cost from $500,000 to $750,000. The dam will be sixty feet high, and develop an estimated horse-power of 30,000. The company has secured land on both sides of the river for several miles.

TO LAY A DUPLICATE NEW YORK-AZORES CABLE—The Deutsch Atlantische Telegraphingesellschaft will soon commence the laying of a new cable from New York to the Azores. Operations will begin at Coney Island, N. Y. The company has now in operation two cables—one from Emden, Germany, to the Azores, and the other from the Azores to New York. Under the present system of transmission, the messages are sent from Emden to the Azores and resent from there to New York. The object of the company in laying the new cable is to automatically connect it at the Azores with the cable from Emden, doing away with the disadvantages of the method now in use.

TRACTION COMPANY MERGER—The following traction companies are to be merged into the Fort Wayne & Wabash Valley Traction Company, which has been formed in Fort Wayne with George F. McCulloch as temporary president: the Fort Wayne Traction Company, the La Fayette Street Railway Company, the Wabash Valley Traction Company, the Wabash & Logansport Traction Company, and the Rochester & Northern Traction Company. The company has in view the purchase of the Fort Wayne & Southwestern Traction Company's line between Fort Wayne and Wabash, and will probably build lines to Elkhart, South Bend, Goshen and some of the northern Indiana summer resorts. The company is to be capitalized at $6,000,000.

CONSOLIDATION OF LIGHTING COMPANIES IN CALIFORNIA—The California Gas and Electric Corporation has purchased the systems of the Standard Electric Company of California, and the United Gas and Electric Company. The Standard company has a capital of $5,000,000 authorized stock and $5,000,000 in bonds, all issued and outstanding. The United Gas and Electric Company was capitalized at $2,500,000 in authorized stock, of which $2,286,000 is outstanding, and has $2,000,000 in authorized bonds, of which $1,100,000 is outstanding. The Standard Electric Company's main plant is in Amador County. It supplies Sacramento and San Joaquin counties, joining with the United Gas and Electric Company in supplying the counties around San Francisco bay, its lines running through San Jose up the west side of the bay into San Francisco.

MINNESOTA POWER COMPANY TO BUILD CANAL—The Minnesota Power and Canal Company, which was organized nearly eleven years ago, and which had been almost forgotten, has again become prominent through a petition which it has recently filed, requesting the condemnation of several hundred acres of land in Minnesota. According to the petition, it is the purpose of the company to construct, maintain and operate a system of canals and waterways in St. Louis, Lake, Cook and Carlton counties, and to supply water power for such manufacturers or individuals as desire it. The company claims to have purchased several sections on the St. Louis river, where the elevation of the stream at low water is 706 feet above the level of lake Superior. It has also certified its intention to build a canal from a point on the St. Louis river to West Duluth, a distance of about twenty-five miles. The company was organized April 15, 1893, and it is understood that the capital is $4,000,000.

TRUST COMPANY TAKES OVER STOCK OF OTHER COMPANIES—The Mackay Companies, an investment trust, has just been organized by Mr. Clarence H. Mackay, president of the Commercial Cable Company, to perpetuate the name of his father, the late John W. Mackay, to enlarge the companies which he originated and to place upon a safe and even basis with his own interests those of the men who have invested in his father's enterprises. Mr. Mackay recently invited stockholders of the Commercial Cable Company to deposit their stock for exchange for shares in the new trusteeship, created under the laws of Massachusetts. For the $15,000,000 capitalization of the Commercial Cable Company, upon which eight per cent dividends are paid, the Mackay Companies has authorized an exchange of 30,000,000 par value four per cent cumulative preferred shares of its own, together with the same amount of common shares. This should give each stockholder in the Cable company 200 per cent for holdings in the new preferred shares and 200 per cent in the new common shares.

A POWER PLANT FOR EVERETT, WASH.—Material is being shipped to lake Isabel for the early beginning of work on the "May creek power plant" by the Everett Railway and Electric Company. It is reported that the plant will be unique in that the head of water will be the greatest in the United States. It is designed to furnish 15,000 horse-power, to be carried to Everett for the street railway, public lighting and private power, as well as for the Everett-Snohomish interurban line of twelve miles, and later to supply other interurban trolley lines which the company is to build. The intake for the thirty-two-inch steel pipe will be thirty feet below the surface of lake Isabel. The pipe will be carried 12,000 feet, with a fall in that distance of 2,500 feet. This distance will be shortened by 4,000 feet if the company determines to tunnel a granite hill lying between the lake and site for the power-house. Owing to the enormous pressure special steel pipe has been ordered. Toward the nozzle the pipe decreases in diameter to twenty inches. The diameter of the nozzle itself will be but five-eighths of an inch. A wheel of the Pelton type will be used. One five-eighths stream will develop 10,000 horse-power. Later, when additional power is needed, another stream and wheel will be installed, developing 6,700 horse-power additional. The pressure on the steel pipe, it is asserted, is 1,100 pounds to the square inch. The speed of the water leaving the nozzle is 25,000 feet, or more than four miles a minute. The cost of the plant will be about $600,000, and it will take the place of a fine steam plant built two years ago. The only plant in the world that exceeds the head of the May creek proposition is one in Switzerland, with a head of 3,700 feet. In California is one with a head of 1,900 feet. The outlet of lake Isabel will be dammed, thus storing enough water for a six months' run.

TELEPHONE AND TELEGRAPH.

POMEROY, OHIO—A new telephone line has been completed from Addison to Cheshire.

BROWNSVILLE, ORE.—The Pioneer Mutual Telephone Company has installed its system in this city.

KENOSHA, WIS.—A new telephone line has been established in this city by the Citizens' Telephone Company.

GOSHEN, N. Y.—The Hudson River Telephone Company will put its wires underground in Newburgh, at a cost of $78,000.

OTTAWA, CANADA—The British Yukon Railway Company has obtained a right of way for a telephone line between White Horse and Dawson.

GALVESTON, TEX.—The Southwestern Telephone and Telegraph Company will expend $80,000 in improving the service at San Antonio.

NEWARK, N. J.—At the annual meeting of the stockholders of the Newark District Telegraph Company, held in this city, the following directors were chosen for the ensuing year: George W.

Hubbell, Frederick T. Fearey, F. C. Runyon, M. L. Ward, William B. Kinney, Thomas W. Dawson and F. O. Runyon.

RICE LAKE, WIS.—A telephone line will be installed in this village at once, it is stated, affording connection with Chippewa Falls, Eau Claire and other points in the vicinity.

SALT LAKE CITY, UTAH—The La Sal Mountain Telephone and Electric Company has leased the Moab & Thompson line for a term of years and the two lines are now under one management.

MODENA, UTAH—Modena is now connected by telephone with the following places: St. George, Cedar City, Toquerville, Washington, Coneryville, Leeds, Pine Valley, Pinto, Enterprise and Bellview.

RUTLAND, VT.—The New England Telephone and Telegraph Company is preparing to build a new line from this city to Burlington, a distance of sixty-seven miles, to replace the present one, which is inadequate.

NASHVILLE, ILL.—The Rixman Telephone Company, of Irvington, has completed its telephone line to this city and has consolidated with the Southern Union company, which is already established in Nashville.

NEWARK, N. J.—At the annual meeting of the Newark Telephone Company it was stated that many improvements had been made last year, and that considerable extension work was contemplated during the present year.

HAZLETON, IND.—A local telephone company has been organized here, with officers as follows: C. S. Stevens, of Princeton, president and manager; C. Chambers, vice-president; W. W. Spain, secretary; H. M. Arthur, treasurer.

CHEYENNE, WYO.—The headquarters of the Rocky Mountain Bell Telephone Company in this city has been transferred to the company's recently completed building. The new switchboard is said to be the largest ever installed in the state.

DUNDEE, N. Y.—The new telephone line from this village to Rock Stream, to connect with Reading Center, thence to Watkins, is assured and will soon be constructed. When completed this will give Dundee and connecting lines communication with Elmira and other important points, and long-distance service south.

AKRON, OHIO—The Springfield Township Rural Telephone Company was organized recently at a meeting of the residents of Springfield township. The company will be capitalized at $10,000. It is the intention of the promoters to build an independent line, and secure city service by affiliating with a local company.

CORTLAND, N. Y.—The Cortland Home Telephone Company has completed arrangements whereby it is able to reach Buffalo by long-distance wires, also all towns in the western part of the state. For some time the service has extended only as far west as Rochester. The company expects soon to get connections with all points in the western states.

CHESTER, VA.—A move is on foot in this county, headed by P. V. Cogbill, E. W. Ellison and others, to establish telephone connections with private residences throughout the vicinity. The line, if built, will touch Chester, Centralia and the courthouse. An effort will be made to form a combination with the present line from the courthouse to the cities.

HAMILTON, OHIO—The Hamilton Home Telephone Company has entered into an agreement with the owners of the Oxford, Darrtown and Morning Sun Telephone companies, by which free service is granted patrons of the lines over each company's entire route. By this agreement over seventy villages in Butler County and Indiana are connected.

WILMINGTON, N. C.—The Columbus Telephone Company hopes to have all its system connected by metallic circuit very shortly, greatly improving the service and affording its patrons long-distance connection through the exchange of the Southern Bell Telephone Company, in Wilmington. The points at present connected by the system are Wilmington, Southport, Cronly, Councils, Lake Waccamaw, Bogue, Whiteville, Chadbourn, Clarendon, Cerro Gordo, Boardman, Clarkton, Bladenboro and Elizabethtown.

EUGENE, ORE.—The Lost Valley Telephone Company has been organized at a meeting of farmers at Goshen. The following officers were elected: J. M. Parker, president; Miss Jennie Parvin, secretary; William Williams, treasurer. The directors are: C. H. Matthews, R. J. Hemphill, Halvor Wheeler, Charles Williams, J. M. Parker. The company intends building a telephone line from Lost Valley to Goshen, a distance of eleven or twelve miles. Later it is intended to build to Eugene, a distance of six miles from Goshen, and connect with the proposed Crow-Llewellyn-Elmira line.

CHATTANOOGA, TENN.—The Cumberland Telephone Company will, as soon as spring opens, begin the construction of a new toll line along the line of the Louisville & Nashville Railroad from New Orleans to Scranton, Miss., where connections will be made with New York and all eastern points. About $160,000 will be the cost of the proposed improvements. A new toll line will also be built along the line of the New Orleans & Northeastern Railroad as far as Meridian, Miss. This line will eventually be built into Memphis. When these new lines are completed the Cumberland Telephone Company will have three separate lines running into New Orleans.

AUTOMOBILE NOTES.

NEW AUTOMOBILE HOME—A plan has recently been started by a number of members of the Automobile Club of America to secure, if possible, the old Manhattan, and later the Knickerbocker, Athletic Clubhouse, at Madison avenue and Forty-fifth street, New York city, for a permanent automobile clubhouse. Nothing definite has yet been done in the matter, and none of the officers would speak officially on the subject at a recent meeting in the clubrooms, at Fifth avenue and fifty-eighth street. An unusually large number of club officials and members was present, as the subject of the recent automobile records made on the Ormond beach was the topic for general discussion, instead of the customary lecture. It will probably be some time before definite plans toward securing a new home are made, if at all. A year ago many members made a strong plea for a thoroughly up-to-date clubhouse. It did not succeed, as the policy prevailed that has been pursued from the organization of the club, to make the club simply a headquarters for members. Most of them belong to one or more of the big social clubs in the city, and it was considered useless to attempt to form another club, which, while devoted chiefly to automobiling, should also compete with the other city clubs in all of the customary club features. Santos-Dumont has been elected an honorary member of the club.

EXTENDED AUTOMOBILE RUN—Plans were perfected recently for the big automobile run to the World's Fair at St. Louis, in which all the leading clubs in every part of the country are to participate. The New York section will leave New York city on Tuesday, July 26, 1904. The New England section will leave Boston one day earlier, on July 25; the southern section will leave Baltimore on July 26, the central section will leave Columbus, Ohio, on August 4, while several intermediate and western sections will start on the run on dates yet to be arranged. All of the sections east of St. Louis will meet at different points along the route. The New England automobilists will join the New Yorkers at Buffalo, the southern section will meet the main body at Cleveland, while the central section, including individual automobile club runs from Indianapolis and St. Paul, will join the immense automobile army at Chicago on August 6. A World's Fair committee has been appointed to arrange for the reception of the visiting automobile host. This automobile run will be in every respect a club run, designed purely for pleasure. It will be under the immediate control of the touring committee of the Automobile Association of America. The new committee appointed at a meeting recently held is: Augustus Post, chairman; Frank X. Mudd, Chicago; H. W. Smith, Syracuse; Charles J. Glidden, Boston; R. R. Scott, Baltimore. Two more members will be appointed to represent Cleveland and St. Louis. In addition to outlining the plans for this big run the directors accomplished several other matters of importance, chief of which was the appointment of a new racing committee. A. R. Pardington will remain as chairman for another year, and his associates will be William K. Vanderbilt, Jr., Osborn Bright and S. M. Butler, of New York; William Wallace, of Boston; George L. Weiss, of Cleveland, and F. C. Donald, of Chicago. Two technical advisers to the committee, a new departure, were also appointed, A. L. Riker representing the American manufacturers and E. F. Birtsall representing the foreign makers. The subject of taking control of autoboat racing was taken up, and a committee composed of Peter Cooper Hewitt and L. R. Adams was appointed to report one month later upon the advisability of such a step by the Amateur Athletic Association.

ELECTRIC LIGHTING.

HEMPSTEAD, TEX.—It is announced that an electric light plant will be established here.

SACRAMENTO, CAL.—An electric power and light plant is to be constructed on the Georgetown Divide.

KESWICK, CAL.—The Northern California Power Company is making preparations to run its lines to Keswick Station.

GLADSTONE, MICH.—The village council of Garden, Delta County, has granted a twenty-year electric lighting franchise to local men.

LA CROSSE, WIS.—The Central Electric Company has leased its plant to the La Crosse Gas and Electric Company for a term of eighteen years.

WHITEHALL, N. Y.—The Consolidated Light and Power Company has made arrangements to light the Delaware & Hudson shops and furnish power.

MERIDIAN, MISS.—The stockholders of the Meridian Light and Railway Company have voted to increase the capital stock from $450,000 to $1,000,000.

WALDEN, COL.—The city council has passed a resolution to grant a franchise to any reliable company which will install a system of waterworks and electric lights.

JERSEY CITY, N. J.—The Harrison town council has adopted the ordinance granting a franchise to the United Electric Company to lay underground conduits in the town streets.

ALBANY, N. Y.—Work has been begun on the electric light plant which the New York Central will erect at West Albany for the purpose of furnishing its own light to all departments.

FAIRPORT, N. Y.—The village of Penfield has decided to install an electric lighting system. Current will be secured from the plant at Lincoln mills, which supplies the village of Despatch.

ASTORIA, ORE.—The Astoria Electric Company has completed arrangements to add largely to its present equipment, and during the present year the electric lighting plant will be doubled.

CLEVELAND, OHIO—An ordinance for a contract with the Cleveland Electric Illuminating Company, for maintenance of arc lights in the city at $75 a lamp a year, has been passed by the council.

BUFFALO, N. Y.—A resolution has been passed by Lockport's common council directing an election on a proposition to install a municipal electric lighting plant in that city at a cost not to exceed $50,000.

GOSHEN, IND.—The Ligonier electric lighting plant, owned by J. W. Draper, and providing street and commercial lights, was damaged by fire recently to the amount of $2,500. The loss is covered by insurance.

ATLANTA, GA.—Fort McPherson is to be lighted electrically, current to be supplied by the Georgia Railway and Lighting Company. Work has been commenced on the installation, and is to be completed by July 1 next. It will cost $14,600.

BIRMINGHAM, ALA.—The Coosa Water Power Development Company has been chartered at Anniston with a capitalization of $250,000. The company has purchased a water power on the Coosa river, and purposes to develop electric power and deliver it to Anniston, Pell and other places.

SHINNSTON, W. VA.—The Shinnston Light and Water Company has been reorganized, G. A. Ferguson, Frank Powell, L. J. Rowand, Leslie Hawker and Hugh M. Martin having been selected as a managing board. The officers are L. J. Rowand, president; George A. Ferguson, vice-president; Hugh M. Martin, secretary, and Leslie Hawker, treasurer.

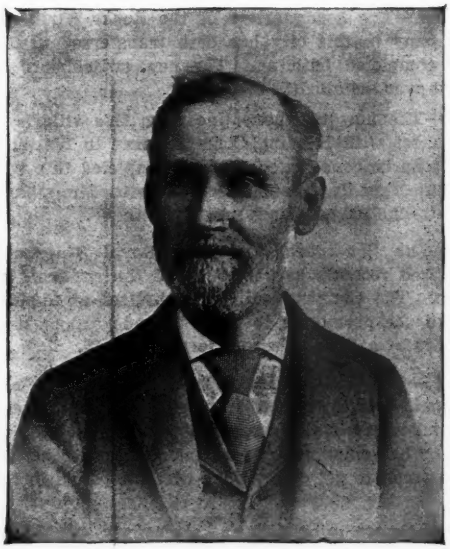
HARRISBURG, PA.—Articles have been filed at the state department between the Shippensburg Gas Light Company, the Shippensburg Electric Light, Heat and Power Company and the Middle Spring Light, Heat and Power Company, forming a company to be known as the Shippensburg Gas and Electric Company. The capital of the new company is $45,000.

YORK, PA.—The directors of the recently chartered Deer Creek Water and Power Company have organized by electing the following officers: president, James H. Gable, York; vice-president, J. Benson Gable; secretary, J. N. Wilson; treasurer, Charles F. Ramsey. The company purposes to construct a dam and power plant on Deer creek, one mile from Stewartstown, and when work is completed will furnish water, power and light to Stewartstown and vicinity.

ROSLYN, L. I.—Clarence H. Mackay, Dudley Winthrop and Edwin D. Morgan have commenced the erection of a $500,000 electric plant at Glenwood, which will be the largest plant of its kind on Long Island. All the principal towns of Nassau County will be supplied, and efforts will be made at once to secure franchises. The same parties have already in operation a large plant at Roslyn, and this will be maintained as a substation on the completion of the plant at Glenwood.

INDIANAPOLIS, IND.—The board of public works has awarded a ten-year contract for street lighting to the Indianapolis Light and Power Company. The company will receive $75 a year for each enclosed arc lamp and $74 for each open arc lamp, the lamps to burn all night. Under the former contract with the company the city paid $85 a year for each light, on a moonlight schedule. The minimum number of lamps to be used is 1,600, an increase of 262 over the present installation.

OBITUARY NOTICE.



MR. ANDREW HOWARD.

MR. ANDREW HOWARD, president of the Phœnix Glass Company, Monaca, Pa., died on Saturday morning, February 27. Mr. Howard had been ill about ten days. His malady, which at first was a form of grippe, developed into pneumonia. The funeral was held at his residence in Wilkensburg, Pa., on Monday, February 29. Mr. Howard was born in Pittsburg in 1837. He was educated in the public schools of that city, and his first employment was as a clerk with the transportation firm of Clark & Thaw, which afterward merged into the Star Union Line, of which Mr. Howard was made the first cashier. He resigned this position in 1880, to organize the Phœnix Glass Company, for the purpose of manufacturing a patent glass insulator. This product was abandoned, and the manufacture of lamp chimneys taken up. From this beginning, and through his enterprise and energy principally, the Phœnix Glass Company has grown to its present large proportions. While he was a man of wonderful tact, discretion and judgment, Mr. Howard was unassuming to the last degree. In his death the glass trade has lost an honored member, and his associates and employés a good friend. He was universally popular, and his benevolence and genial spirit won for him the entire affection of all with whom he came in contact. Mr. Howard's popularity with the employés of the Phœnix Glass Company was evidenced by their attendance at the funeral, special trains being run from the Washington and Monaca factories. The floral offerings were expressive of the general high esteem in which the deceased was held, and came in profusion from his business associates, the Glass Manufacturers' Association and his business employés.

PERSONAL MENTION.

MR. AND MRS. W. C. WOODWARD, of Providence, R. I., left last week, Thursday, for a visit to Bermuda. Mr. Woodward is electrical engineer of the Narragansett Electric Light Company.

MR. R. J. McCLELLAN has been appointed electrician of the Puget Sound Electric Railway, Tacoma, Wash., to succeed Mr. C. A. Sears, resigned.

MR. L. S. MILLER has been appointed general manager of the Central New England Railway, with offices at New Haven, Ct., to succeed Mr. D. A. Geraty, resigned.

MR. J. B. COWEN, advertising manager of the General Incandescent Arc Light Company, New York city, has returned from an extended trip abroad. Mr. Cowen reports the present business for his company very extensive, and the outlook everything that could be wished for.

MR. A. HOWELL VAN CLEVE has been appointed resident engineer of the Niagara Falls Power Company, to succeed Mr. W. A. Brackenridge, resigned. Mr. Van Cleve is a graduate of Lehigh University, class of 1890, and has been connected with the Niagara Falls Power Company since 1892.

MR. GEORGE S. BINCKLEY, consulting engineer, of San Francisco, Cal., is chief engineer of the engineering and construction work of the Columbia Improvement Company, at and in the vicinity of Electron, Wash., including the dam and headworks on the Puyallup river, about ten miles from Electron.

MR. W. A. BRACKENRIDGE, C. E., who was connected with the Niagara Falls Power Company, Niagara Falls, N. Y., for some time past, has been appointed a member of the special advisory commission, which will consist of five expert engineers, who will supervise the construction of the $100,000,000 barge canal.

MR. CLEMENS HERSCHEL, who is to take charge of the hydraulic machinery department of the Allis-Chalmers Company, Chicago, Ill., was formerly hydraulic engineer of the Holyoke (Mass.) Water Power Company, also consulting hydraulic engineer from time to time for numerous Niagara water power companies.

MR. CHARLES T. CHAPIN, who for many years was the president of the Rochester Car Wheel Works, Rochester, N. Y., has been elected vice-president of the National Car Wheel Company, which is a consolidation of the Rochester Car Wheel Company, Rochester, N. Y.; Keystone Car Wheel Company, Pittsburg, Pa.; Maher Wheel and Foundry Company, Cleveland, Ohio, and the Cayuta Wheel and Foundry Company, Cayuta, Pa.

MR. G. M. GEST, the expert subway contractor, of New York, Cincinnati and Chicago, has been awarded the contract for the construction of a heavy forty-duct conduit system by the Public Service Corporation of New Jersey. This system will cost several thousand dollars, and is a main trunk feeder line running through Hoboken and Jersey City. Work is to be begun on March 15, and a large force of men will push it to completion as rapidly as possible.

MR. T. H. CREDEN has undertaken the compilation of a comprehensive index of all the volumes of proceedings of the National Electric Light Association since its first convention. Mr. Creden is one of the best statisticians in the electric lighting business, and is also a well-known constructing and operating engineer, having served in both these capacities with the Chicago Edison Company and with Messrs. Stone & Webster. It is intended to have the complete index printed before the Boston meeting of the association, which is to be held on May 24, 25 and 26. This index will be of great assistance to the members of the association, as it will make it an easy matter to find at once any topic or paper to which reference is desired.

MR. B. A. BEHREND has been retained as chief electrical engineer for the allied Allis-Chalmers and Bullock electric interests. Mr. Behrend has been connected with the Bullock company for four years, and in that time has designed alternating-current and direct-current machinery with an aggregate capacity of some 200,000 kilowatts. These machines are all in the most successful operation, not only in the United States, but in several foreign countries. Some notable installations are to be found at Quebec, Montreal, Nashville, Denver, San Francisco and Los Angeles, and some of the large railroads using this apparatus are at Indianapolis, Shelbyville, Scioto Valley and Los Angeles. Mr. Behrend was born in Pomerania, Germany, on May 9, 1875. After finishing his studies at the Berlin Polytechnic Institute and University, he took up practical engineering under Helmholtz, Kundt, Slaby and Riedler, and, for a short time, was associated with Gisbert Kapp. He was assistant chief electrician of the Oerlikon Company, Zurich, Switzerland, and upon leaving this company, in 1899, came to the United States. Since 1900 Mr. Behrend has been associated with the Bullock Electric Manufacturing Company. He is a popular figure in the engineering fraternity, and is a member of the American Institute of Electrical Engineers, chairman of the Cincinnati chapter of the Institute, and a fellow of the American Association for the Advancement of Science.

ELECTRICAL SECURITIES.

There appears to be little prospect for any immediate change in stock market conditions. No new developments of any importance have occurred in either the foreign or domestic situation. The coming presidential election, with the more or less demoralized condition of either party with regard to a leader, is looked upon as an unsettling element in many quarters. Electrical manufacturers, in general, report a prospect for a very busy season; and in all lines of construction the present outlook does not justify any apprehension of a severe retrogression. Of course, it will probably be some years before the high level which was reached in commercial activity last year will be again attained.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MARCH 5.

New York:	*Closing.*
Brooklyn Rapid Transit	39¾
Consolidated Gas	191½
General Electric	160½
Kings County Electric	183
Manhattan Elevated	143
Metropolitan Street Railway	113¾
New York & New Jersey Telephone	140
Westinghouse Manufacturing Company	170

Commercial Cable directors have declared the regular quarterly dividend of 2 per cent, payable April 1. Books closed February 25 and reopened March 8.

A quarterly dividend of 1½ per cent on the capital stock of the Manhattan Railway Company for the quarter ending March 31, 1904, and an additional dividend of 1 per cent for the year ending March 31, 1904, have been declared, in compliance with the terms of the lease of the Manhattan Railway Company to the Interborough Rapid Transit Company, payable at the office of the company, 195 Broadway, New York city, on and after April 1, 1904. The transfer books closed March 12, and will reopen March 23.

Boston:	*Closing.*
American Telephone and Telegraph	121½
Edison Electric Illuminating	232
Massachusetts Electric	73
New England Telephone	118
Western Telephone and Telegraph preferred	78

Philadelphia:	*Closing.*
Electric Company of America	7⅞
Electric Storage Battery common	52
Electric Storage Battery preferred	52
Philadelphia Electric	5¾
Union Traction	47½
United Gas Improvement	83

Chicago:	*Closing.*
Chicago Telephone	117
Chicago Edison Light	150
Metropolitan Elevated preferred	45
National Carbon common	26½
National Carbon preferred	99
Union Traction	4¾
Union Traction preferred	29⅝

The directors of the Chicago Telephone Company have declared the regular quarterly dividend of 2½ per cent, payable March 31. Books close March 25 and reopen April 1. The February statement shows a gain of 1,724 telephones, making the total now in use 104,368.

The daily average of passengers carried on the Northwestern Elevated Railroad for February was 73,193, an increase of 3,308.

Metropolitan Elevated for February showed a daily average of passengers carried of 119,073, an increase of 2,983.

South Side Elevated for February showed a daily average of 90,330 passengers carried, an increase of 1,814. The small gain is attributed to the severe weather.

INDUSTRIAL ITEMS.

THE FROST CROSS ARM AND LUMBER MANUFACTURING COMPANY, Cleveland, Ohio, has issued a leaflet containing some points in connection with "Frost" cross arms. Leaflet will be sent on request.

THE J. S. MAURER & COMPANY AGENCY has recently carried through the sale of the Milford Electric Light and Power Transmission Company, Milford, Ill., to Mr. E. Lindner, of Pecatonica, Ill. Price, $15,000.

THE LAIDLAW-DUNN-GORDON COMPANY, Cincinnati, Ohio, has just sent out its bulletin No. L508, which has just been published. This bulletin treats very fully on the improved "Cincinnati" air compressor. It will be sent on request.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has just issued the March copy of "Graphite." This number, like previous ones, contains interesting information in connection with the use of graphite. Copy will be sent on request.

THE EAGER ELECTRIC COMPANY, Watertown, N. Y., illustrates and describes in a catalogue which it has sent out direct-current generators and motors for lighting and power which it manufactures. This catalogue will be sent on request.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., illustrates and describes in catalogue No. 60, which it has sent out, alternating-current machinery which it manufactures for lighting, power and railway service. Catalogue will be sent on request.

WILLIAM ROCHE, dealer in new standard electrical specialties, announces the removal of his offices to 52 Park place, New York city, N. Y., where all future communications should be addressed. Due to a large increase in business, it became necessary for Mr. Roche to seek larger quarters.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, is sending out its bulletin No. 1002A. This bulletin treats on the "Bullock" type "N" motors, which were especially designed for direct connection to machine tools and for other similar service. Bulletin will be sent on request.

THE RAILWAY AND ELECTRIC EQUIPMENT COMPANY, Buffalo, N. Y., has just issued its new classified list No. 2. Part I of this list treats on electrical machinery for trolley roads and lighting, and part II treats on railway equipment for steam roads and miscellaneous equipment. List will be sent on request.

THE OSBURN FLEXIBLE CONDUIT COMPANY, 21 Park row, New York city, manufacturer of "flexduct," for interior wiring, reports a large number of advance contracts. This conduit has become very popular for modern building wiring, and the company's works is being taxed to keep up with the demand for this product.

THE CANADA CORUNDUM COMPANY, LIMITED, Toronto, Canada, is sending out an announcement stating that its new mill has been completed and it is now in a position to supply the wants of all customers. The company is now open to make contracts to furnish concerns with from one to three years' supply of pure Craig mine corundum.

WICKES BROTHERS, New York city, N. Y., manufacturer of boilers and machinery, has issued its March, 1904, monthly stock list of new and second-hand boilers, engines, pumps, generators, and other power equipment and iron-working machinery. List will be sent on request. The company also announces that it has opened a salesroom at 113-115 Cedar street, and has moved its offices formerly located at 95-97 Liberty street to that address.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., and Chicago, Ill., publishes a handy little booklet entitled "Telephone Troubles; Their Cause and How to Remedy." The price of this is ten cents. A novel mailing folder which the company has just issued is in imitation of a packing case. The folder contains a description and illustrations of a five-line switching telephone for party-line service.

THE GOLD CAR HEATING AND LIGHTING COMPANY announces that it has recently made arrangements with Mr. Thomas A. Edison and his company, whereby it becomes the exclusive sale agent in the United States for the Edison storage battery for car lighting purposes. It also announces that it has taken a large suite of offices in the Whitehall Building, New York city, N. Y., and has moved both its Chicago branch office and its New York office to that address.

THE VITRO CHROME CHEMICAL COMPANY, Milwaukee, Wis., will be pleased to send to those interested in the coloring of incandescent lamp bulbs several booklets which it has recently issued concerning "vitro chrome," a new chemical discovery for coloring incandescent lamp bulbs. This is stated to produce a brilliant and durable transparent color, and offers a satisfactory substitute for color-blown glass. "Vitro chrome" is a fluid preparation into which the lamp or glass is dipped.

THE MARLIN FIRE ARMS COMPANY, New Haven, Ct., is sending out a catalogue arranged in three sections. The company has made it a point in this catalogue to illustrate and describe its manufacture in a manner which can be easily understood. Part I is designed for the quick reference of dealers and consumers. Part II is intended for consumers who wish detailed information, and Part III gives hints that will possibly interest all those concerned with fire-arms. Catalogue will be sent on request.

THE MICHIGAN CENTRAL RAILROAD COMPANY, through its passenger department, is distributing a lithographed calendar showing the Great Cataract from the Falls View station of the Michigan Central Railroad Company. This calendar is for the current year ending March 1. The company distributes a great deal of attractive literature, and this is, no doubt, one of the most important elements in inducing leisure travel. The new calendar does not fall short in attractiveness, and portrays very faithfully the natural beauty of the scene from this station. Mr. W. H. Underwood is the general eastern passenger agent of the company, with offices at 486 Ellicott square, Buffalo, N. Y.

THE NORTHWESTERN ELECTRIC COMPANY, 71 West Washington street, Chicago, Ill., makes a specialty of expert electrical repair and construction work. This company also has on hand a stock of dynamos and motors, wattmeters, instruments and supplies, both new and second-hand. The company is distributing a valuable souvenir in the shape of a lithographed aluminum card, announcing the company's headquarters, and bearing on the back a wire table giving the B. & S. gauge of wires from 0000 to No. 18, the weights per 1,000 feet in pounds with triple-braided insulation, the area in circular mils of the bare wire, and the safe carrying capacity in amperes. It also gives a formula for finding the circular mils in terms of the current in amperes, the distance in feet and the loss.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., is issuing bulletins Nos. 4359, 4360, 4361, 4362, 4363, 4364, 4365 and 4366. Bulletin No. 4359 treats very fully on the series alternating system of arc lighting and contains many interesting half-tones and line cuts. 4360 illustrates and describes cable terminals and contact nuts. In 4361 the "GE-70" motor is shown and described. This motor embraces in its construction the latest developments in railway motors. 4362 treats on carrier bus arc panels for "Brush" arc generators. 4363 illustrates and describes type "B" indicators for direct-current service. In 4364 a series incandescent system and a complete line of constant-current transformers are described and illustrated. 4365 treats on line drop compensators, type V, for alternating-current circuits. 4366 treats very fully on the "Thomson" polyphase recording wattmeters. All of these bulletins will be sent on request.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has recently closed a number of contracts for the installation of batteries of chloride accumulators. Among them may be noted two batteries of the North Shore Railroad Company, one to be located at San Anselmo, Cal., having a capacity of 846 kilowatts; the other located at Sausalito, Cal., having a capacity of 975 kilowatts. Both these batteries to be used for line regulation. The Bay City Traction and Electric Company, Bay City, Mich., has contracted for a battery having a capacity of 288 kilowatts, this battery to regulate the fluctuations of the generator load. The Northwestern Fuel Company, Superior, Wis., has contracted for a battery having a capacity of 677 kilowatts, which is to be used entirely for the regulation of a motor load. The Bartlett Illuminating Company will install for the use of the Saginaw Traction Company a battery having a capacity of 200 kilowatts, to be used in regulating the fluctuations on the latter company's railway circuit.